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MEMOIRS

OF THE

CARNEGIE MUSEUM.

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CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM.

By C. R. Eastman.

Part IV. Descriptive Catalog of Fossil Fishes from the Lithographic Stone of Solenhofen, Bavaria.*

(Plates LVII–LXXIII.)

The present paper deals with the fossil fishes from Solenhofen, and is principally based upon the fine collection of these acquired through the generosity of Mr. Andrew Carnegie in 1903, when the paleontological treasures amassed by Baron Bayet were purchased for the Museum. The Bayet Collection, by far the largest and most important assemblage of Mesozoic fishes from European localities to be found in any institution on this side of the Atlantic, compares favorably with many of the best known European collections from the same locality. A splendid suite of specimens illustrating the ichthyic and reptilian fauna of the Solenhofen deposits is to be seen on exhibition in the Hall of Fossil Vertebrates, where it constitutes an imposing display.

* In July, 1913, Dr. C. R. Eastman submitted to the Director a manuscript upon the Fossil Fishes from Solenhofen contained in the Carnegie Museum. For reasons, which it is not necessary here to state, various delays occurred in the preparation of the manuscript for publication and of the plates which accompany it. The present paper cannot be accepted as a perfect catalog of the fossil fishes from Solenhofen contained in the Carnegie Museum, but because it embodies some valuable information and tends to throw new light upon the subject the Editor gives it to the public. *W. J. Holland.*

It must be regarded as an exceedingly fortunate circumstance for paleontology that calcareous deposits of the kind known as Lithographic Stone should occur in the Upper Jurassic rocks of various parts of Europe, more especially in northern Bavaria and in the Department of Ain, France, because of the excellence of preservation in this medium of the most delicate structures and impressions.

Laid down in the shallow lagoons of coral atolls in the form of fine calcareous ooze, the material itself, and the conditions under which it was deposited, lent themselves to the registration with extreme fidelity of the structural features of the organisms which were imbedded in it. In consequence it not infrequently happens in the case of the fishes that we are acquainted not only with the entire skeletal anatomy and the minute details of the hard parts, but even with soft tissues, such as the muscular fibres, the air-bladder, the intestinal tract, the fin-membranes, and in a few rare instances with the egg-capsules of cartilaginous forms. The favorable circumstances of preservation, to which these structures and others equally delicate, such as the plumage of *Archæopteryx* and impressions of *Medusæ* bear witness, have enabled us to study fossil organisms embedded in hard rock with a degree of minuteness, which is scarcely possible elsewhere throughout the stratigraphic column.

A few words as to the general character of the ichthyic fauna of Solenhofen may be appropriate. It is chiefly composed, as is the universal rule in strata of Mesozoic age, of "ganoids," that is, of teleostomous fishes belonging to both the Crossopterygian and Actinopterygian orders. A number of interesting survivals of archaic types are to be observed, not the least remarkable among which belong to the group of primitive sturgeons, *Chondrostei*, and to the characteristically Mesozoic suborder known as *Protospondyli*. Examples are furnished under either head by the genera *Coccolepis* and *Homœolepis* which are the terminal members of the long-lived series to which they respectively belong, the *Palæoniscidæ* and *Semionotidæ*. *Undina* presents another illustration.

The Dipnoan subclass, which formed so important an element of the Paleozoic vertebrate fauna, is without known representatives in the strata under consideration, or indeed anywhere in the Jurassic, the group having declined markedly in the Trias, although its more generalized members continued to survive until modern times.

Coincident with the decline of Paleozoic lung-fishes is to be noted the almost total extinction of Elasmobranchs toward the close of the older era, in which they had been especially prolific. Nevertheless fragmentary remains of this class are recognizable in rocks of Triassic age, and entire skeletons of undoubted Selachians

(*Palæospinax*) are known first from the Lower Lias. These latter have completed vertebral centra, and the Upper Jura furnishes examples of well-formed vertebræ of the types characteristic of modern sharks and rays, that is to say, truly asterospondylic and tectospondylic vertebral centra. Students of the group are well aware that, as was first demonstrated by Prof. Carl Haase, the time-honored division of Selachii into sharks and rays corresponds very closely to constant differences displayed by the structure of the vertebral bodies. In the rays, or *Tectospondyli*, a series of concentric lamellæ surrounds the primitive double cone of each vertebral centrum; in the majority of sharks (*Asterospondyli*) the centra, when fully developed, are strengthened by longitudinal ridges or radiating laminæ, which, when viewed in transverse section, present a stellate appearance.

Typical representatives, therefore, of the suborders embracing modern sharks are met with in the fauna of the Lithographic Stone of Bavaria. Nearly complete examples are known of a shark resembling the recent Cestracion (*Heterodontus*), and the same is true of certain dog-fishes, *Scyllium* and *Pristiurus*, while beautifully preserved skeletons of *Squatina* and *Rhinobatus*, scarcely to be distinguished from their modern successors, occur in the same horizon. Turning our attention finally to the order or sub-class of Holocephali, this is represented in the fauna under discussion by two genera, *Chimæropsis* and *Ischyodus*. The collections of the Carnegie Museum do not contain examples of either of the two last-named genera, but the deficiency is more than compensated by a number of splendidly preserved rays, including a magnificent *Rhinobatus* from Eichstädt, the counterpart of which is figured in von Zittel's "Handbuch der Paläontologie," Vol. III, p. 102.

An inspection of the subjoined classificatory scheme will permit the major divisions of the class Pisces, which enter into the constitution of the fauna of the Lithographic Stone, to be recognized at a glance.

Class PISCES.

Subclass.	Order.	Suborder.
Elasmobranchii	(*Pleuropterygii*)	Not represented.
	(*Ichthyotomi.*)	"
	(*Acanthodei.*)	"
	Plagiostomi	*Selachii.*
		Batoidei.
	Holocephali	*Chimæroidei.*

Subclass.	Order.	Suborder.
Telcostomi	*Crossopterygii*	*Actinistia.*
	Chondrostei.	
	Holostei.	
	Teleostei.	

After these brief introductory remarks we pass on to the enumeration of the genera and species of the fishes from Solenhofen which are represented in the collections of the Carnegie Museum.

CLASS PISCES.

Sub-Class I. ELASMOBRANCHII.

"The Elasmobranchs are certainly a very primitive race of Fishes. Their earliest representatives of whose structure we have any precise knowledge (*e. g.*, *Cladoselache* and *Pleuracanthus*) are in many respects the most archaic of known gnathostomatous Craniates, and from such types as these, among others, we may very reasonably look for the ancestors of all or most of the remaining groups of Fishes. It has been well said of *Pleuracanthus* that 'it is a form of Fish which might with little modification become either a Selachian, Dipnoan, or Crossopterygian,'[1] while the condition of the primary upper jaw in the Chondrostean *Polyodon* suggests that even the more primitive Actinopterygii had an Elasmobranch origin." (Cambridge Natural History, Fishes, pp. 435–6.)

We here follow the arrangement adopted by Professor T. W. Bridge in the Cambridge Natural History, grouping the Selachians and Batoidei under the ordinal term of Plagiostomi. It should be borne in mind, however, that authorities are not agreed as to the propriety of maintaining these subdivisions in the ordinary manner, that is, classifying as sharks those cartilaginous fishes which have lateral gill-clefts, and as rays those with ventral gill-clefts. More or less constant differences exist with regard to the manner of specialization of the vertebral centra, as indicated by the terms asterospondylic and tectospondylic, and it is further recognized that modern sharks and rays form two approximately natural groups, the former tending towards agility in swimming, the latter towards expertness in feeding on the bottom. Although a few existing sharks have become adapted for life on the sea-bottom and have a depressed form of body, nevertheless they do not have the enlarged pectoral fins which belong to the rays, and the anal fin in no case disappears, as it does in the latter.

[1] Smith Woodward, Vert. Palæont., 1898, p. 32.

Order **PLAGIOSTOMI.**

Suborder *SELACHII.*

Family CESTRACIONTIDÆ.

Genus CESTRACION Cuvier.

"To this existing genus, commonly known as the Port Jackson shark, have been referred certain skeletal remains, not as yet satisfactorily distinguished from it, which occur in the Lithographic Stone of Bavaria. The type-specimen, upon which the so-called '*Acrodus falcifer*' Wagner (= *Cestracion*) was founded, is preserved in the Paleontological Museum at Munich, and other imperfect portions of the skeleton are to be seen in the British Museum. None, however, exhibits the entire outline and fin-characters at all satisfactorily."[2]

1. **Cestracion falcifer** Wagner.

(For references to the literature prior to 1911 *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 332.)

1911. *Cestracion falcifer* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 400.

"The typical example of this species shows every indication of being an adult individual and is estimated to have had a total length of about 40 cm. In it the two dorsal fin-spines are seen to be of unequal size, both are slightly recurved, and that of the anterior dorsal is inserted at a point about midway between the origin of the pectorals and posterior dorsal fin. It would appear from the published figures, also, that the pelvic pair arises opposite the first dorsal; and the shagreen granules are described as 'schaufelförmige oder körnelige,' without being markedly differentiated in size.

"To this species has been referred by von Zittel (*loc. cit.*, p. 77) a well preserved smaller individual, the total length of which is only 12.5 cm., or less than one-third of that of the type. According to the same author this smaller specimen, which he regards as the young of *C. falcifer*, has feebly striated lateral teeth, and is provided with enlarged stellate tubercles in the dorsal region. The description of this feature reads: 'Neben den schaufelförmig gestalteten Chagrinschuppen liegen in der Rückenregion kurze gekrümmte Stacheln, welche sich auf einer vierstrahligen Basis erheben.'

"It cannot escape notice that the smaller example just referred to presents characters in common with the well-preserved specimen in the Carnegie Museum from the same horizon and locality, immediately to be described as the type of a

[2] Eastman, C. R., Am. Jour. Sci. (4), Vol. XXXI, p. 400.

new species, and it seems proper to associate under the latter head the small shark, which von Zittel regarded as the young of *C. falcifer*."[3]

2. Cestracion zitteli Eastman. (Plate LVII, fig. 1.)

1911. *Cestracion zitteli* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 401, pl. I.

Type.—Nearly complete skeleton; Carnegie Museum (Cat. No. 4423).

"The example, which is here regarded as typifying a distinct species, merits special attention on account of its being probably the most perfect post-Liassic Cestraciont shark, which has thus far been discovered in the fossil state. Agreeing in principal characteristics with the small form described by von Zittel as the young of *C. falcifer*, as above stated, its features are nevertheless judged to be sufficiently distinctive to warrant a separation from that species.

"The more important differences relate to the position of the dorsal fins, form and relative size of the dorsal fin-spines, number and size of the vertebral centra, and presence of a series of enlarged, radially ridged, and acutely conical shagreen tubercles along the back. A comparison of characters displayed by the dentition in the type-specimen is impossible, as the teeth are unfortunately not preserved, but in the small Munich example, which may be with entire propriety associated with the type now under description, the lateral teeth are said to be 'mit einer Anzahl von Zacken versehen.' This may be understood to mean that the oral surface is faintly rugose, transversely striated perhaps, or else that the coronal margin is slightly indented. In any case, however, the teeth must have been exceedingly minute.

"A summary of the chief features of interest presented by the type-specimen may be given as follows: Form of body slender and elongate; total length from extremity of snout to that of the vertebral column about 15 cm. Vertebral centra varying somewhat in length, being more compressed in a longitudinal direction underneath the second dorsal fin. About twenty-five centra occupy the interval between the bases of the two dorsal fin-spines, and it is noteworthy that these latter abut almost directly against the column. . . . The spines themselves are of relatively large size, smooth, sharply pointed distally, and only slightly arcuate or recurved."[4] They were evidently deeply implanted in the soft parts, but have become to a slight extent displaced from association with the front margin of the fins prior to fossilization.

[3] Eastman, *l. c.*

[4] Eastman, C. R., Am. Jour. Sci. (4), Vol. XXXI, 1911, p. 401.

"Portions of the fin-membrane or shagreen-covering of the pectoral pair, as well as the greater part of the pelvic, anal, and caudal fins are preserved. The anal is nearly opposite the posterior dorsal, and except for being more sharply pointed, resembles it in form and proportions. The pelvic pair is decidedly acuminate, and placed midway between the anal and pectoral pair. The pelvics slightly exceed the second dorsal in size, which latter is somewhat higher and longer than the first dorsal; and the depth [width] of the pectorals is about one third greater than that of the pelvic pair. Nearly the entire front margin of the right pectoral fin is preserved, but the distal portion of the left pectoral is either concealed or broken away. The same is true of the terminal part of both lobes of the caudal."[5] The general outline of body and position of all the fins is shown in Plate LVII, fig. 1. The shaded area immediately behind the head and thoracic region indicates a fracture in the containing rock.

The configuration of the head is well shown by a continuous mass of calcified cartilage and closely crowded shagreen granules preserved in natural position. Teeth are not visible, the head being exposed from the dorsal aspect without indications of mouth-parts. Two forwardly placed openings are probably to be interpreted as nasal and orbital respectively.

Fine shagreen granules bearing each a single acuminate recurved spine occur in regular series everywhere over the surface of the body, and cover the fin-membranes as well. Just above the vertebral column and evidently indicating the median

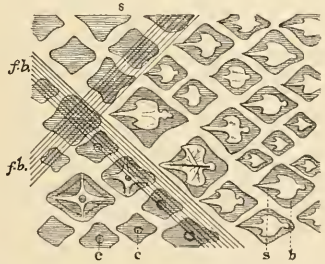

Fig. 1. Surface view of the dermal denticles of *Scyllium sp.* (From Bridge after Klaatsch, Cambridge Natural History, Vol. on Fishes, p. 184, fig. 99.) *b*, basal plate; *c*, canal which perforates basal plate and becomes the axial pulp-cavity of the spine; *f.b.*, intersecting fibrous bands of the dermis; *s*, spine; in the spine of one scale the dentinal tubules are shown. The smaller denticles are those most recently formed.

line of the back is a longitudinal series of spinules corresponding to ridge-scales, which extends from the anterior dorsal fin caudad nearly to the base of the upper lobe of the tail.

[5] Eastman, C. R., *l. c.*, pp. 401–402.

These spinules are not very greatly enlarged, but in advance of the first dorsal fin they become interspersed with, and finally replaced by, a series of much larger shagreen-scales, the surface of which is elevated into a number of sharp ridges radiating from a common point of intersection. These stellate spicules are longest along the front margin of the first dorsal fin, but smaller ones of similar form, or more frequently with two rays meeting at right angles, are distributed over the region of the head. These structures are no doubt identical with those described by von Zittel as "vierstrählige Schuppen" in the Munich example already referred to. Klaatsch's figure of the shagreen-denticles in a modern dogfish is reproduced herewith to illustrate the manner of arrangement. Both the shagreen and calcified cartilage in various portions of the body are exquisitely preserved in the specimen.

Family SCYLLIDÆ (Dog-Fishes).

Genus Phorcynus[6] Thiollière.

Dorsal fins above the pelvics and anal respectively, which latter are small. Form of body slender, length of head contained about five times in the total length. Tail of moderate length, with axis flexed upward in well-developed superior caudal lobe.

3. **Phorcynus catulinus** Thiollière. (Plate LVII, fig. 2.)

1854. *Phorcynis catulina* Thiollière, Poissons Fossiles etc. dans le Bugey, p. 9.

1889. *Phorcynis catulina* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 458.

1911. *Phorcynus catulinus* C. R. Eastman, Am. Journ. Sci. (4), Vol. XXXI, pp. 402–3.

This is the only known species and type of the genus, which attains a length of about 40 cm. In the form and position of the fins it closely resembles the recent *Ginglymostoma*, except for the slightly more anterior origin of the first and second dorsals.

[6] *Phorcynis* Thiollière; *Phorcynus* Eastman, Am. Journ. Sci. (4), Vol. XXXI, 1911, p. 402 (*errore*). (*Error hic iteratus*). The Editor takes occasion to emphatically protest against the change which has been made in this generic name by Dr. Eastman. The change is contrary to the laws of priority (*cf.* Proc. Seventh Internat. Zoöl. Congress, p. 43, Art. 19). Thiollière in forming the name took the stem of the Greek noun φορκῦς, which is φορκῦν-, and added the feminine ending ις, thus forming a noun, which may be interpreted to mean "a sea-goddess." He might better have added the Greek inflectional ending η, but he did not. At this date, after the name has been accepted by two generations of scholars, it is rather late to propose a modification. At the insistence of Dr. Eastman I leave the name as he has spelt it, but record my protest against the liberty he has taken. If arbitrary changes like this are constantly to be made, there never will be any possibility of arriving at "a stable scientific nomenclature" in ichthyology, or any other of the natural sciences. *W. J. Holland.*

"Our knowledge of this species has depended hitherto solely upon the type specimen, which lacks the anal and is in other respects incomplete. It must be regarded, therefore, as an extremely fortunate occurrence that a second and more perfect example of this forerunner of modern Dogfishes should have been discovered a half-century after the first was found, and should provide the means of further enlightenment concerning this genus and species.

"The total length of the Carnegie Museum specimen, which bears the catalogue number 4780, is a trifle less than 40 cm. It is a little difficult to determine the exact length of the head, but it was apparently contained between five and six times in the total length. The outline of the cranial roof, including the orbits on either side, and that of the lower jaw, is clearly shown. In the ethmoidal region and elsewhere in the body, the rounded or polygonal tesseræ of the endoskeletal cartilage are beautifully displayed, and the same remark applies to the fine shagreen-granules occurring throughout the integument. Just beneath the orbital cavity are to be seen impressions of a few minute teeth, each provided with one principal and a pair of lateral cusps.

"The vertebral column is preserved intact almost to the extremity of the tail, being flexed upward to support the upper caudal lobe. Ninety-six vertebral centra are to be counted in continuous series, and it is probable that not more than five or six are missing from the posterior extremity. The centra are of the usual hour-glass form, and do not call for any special comment.

"Both the median and paired fins are very well preserved. The pectorals are large, lappet-like, not abruptly truncated distally as in modern representatives of *Scyllium*, but obtusely pointed, as is the case in Cretaceous species of *Palæoscyllium*. The low pelvic fins arise at a point opposite the middle of the first dorsal. The endoskeletal supports consist of at least a dozen segmented radialia. The first dorsal arises at about the middle of the back, is of triangular form and moderate height, with twelve or more strong radialia. The second dorsal is similar to the first, but smaller, and the gently rounded anal lies directly beneath its posterior half. The tail is strongly heterocercal, in this respect differing from *Palæoscyllium* and resembling the recent *Ginglymostoma*.

"A minor feature which deserves perhaps casual mention is the preservation within the intestinal tract, near the vent, of portions of undigested food, including small ganoid scales, fragments of a small finely striated dorsal fin-spine (doubtless the young of some Cestraciont shark), and a number of small Echinoid spines, besides a few Foraminifera tests."[7]

[7] Eastman, *l. c.*

The close resemblance between the genus and species under consideration and the form described by Wagner as *Palæoscyllium formosum*, from the Kimmeridgian of Solenhofen, appears to have been overlooked by students of fossil fishes generally. This inadvertence is perhaps attributable, however, to the imperfect condition of the type-specimen which served for Thiollière's description, although in the text it is stated that the anal fin has not been preserved, and the outlines of all the others are indicated merely by a slight discoloration of the matrix. "Le contour du corps et de toutes les nageoires est indiqué seulement par la coloration différente de la pierre, et le relief n'est sensible que pour la colonne dorsale" (*l. c.*, p. 10). Judging from the published figure, the fin, which Thiollière interprets as one of the pelvics, is more properly to be regarded as a displaced pectoral belonging to the opposite side of the body. If a pelvic, it must have been displaced forwards.

Genus Palœoscyllium Wagner.

"First dorsal fin above or partly behind the pelvics; origin of second dorsal in advance of the anal, which is small. Tail of moderate length."[8] Teeth minute, with at least one pair of lateral cusps.

4. **Palæoscyllium formosum** Wagner.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 338.)

This species, which is the type of the genus, attains a length of about 40 cm. Pectoral fins large, in form resembling those of the existing *Scyllium*. Pelvic fins completely beneath the first dorsal; anal fin beneath the hinder portion of the second dorsal. Vertebral column composed of about one hundred asterospondylic centra.

Known only by the original of Wagner's figure and description, this species is worthy of notice in this connection on account of its close affinity to the preceding genus. The Cretaceous *Thyellina* of Agassiz is also a near ally.

Suborder *BATOIDEI.*

Family SQUATINIDÆ.

Genus Squatina Duméril.

All known fossil Squatinidæ exhibit the characters of this, the single surviving genus, and are consequently referred to it. The earliest species are of Upper Jurassic age. They resemble sharks in having lateral gill-clefts, but agree with *Rhinobatus* in the forward extension and lateral expansion of the pectoral fins;

[8] A. S. Woodward, Cat. Foss. Fishes, Vol. I, p. 338.

and their general structure points to their being probably survivors of ancestral rays.

5. **Squatina alifera** Münster. (Plate LXVII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 66.)

"Head gently rounded and blunt in front. Dermal granules varying from simple or stellate hooklets to blunt, rounded tubercles; no great mass of the latter observed in advance of the head or paired fins. Caudal fin very large" (A. S. Woodward, *l. c.*, Pt. I, p. 67).

One excellently preserved specimen belonging to this species, in some respects more perfect than the type, is to be seen on exhibition in the Hall of Vertebrate Paleontology of the Carnegie Museum. The structure of the head, pectoral and pelvic arches, fin-rays, the dentition, etc., is very well shown. The anterior dorsal and caudal fins are not indicated. The posterior dorsal fin is triangular, of comparatively large size, and situated about midway the length of the tail, as in the type. The total length of the fish is about 88 cm.

6. **Squatina minor** Eastman. (Plate LVII, fig. 3.)

1911. *Squatina minor* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 403, Pl. III.

Type.—Complete skeleton; Carnegie Museum (Cat. No. 4737).

In general like the preceding species, but distinguished from it by its smaller size (total length 49 cm.), relatively narrower disk, and more posterior position of both dorsal fins. The first dorsal arises at a point about one-third of the distance between the hinder extremity of the pelvic fins and the tip of the tail; the second dorsal midway between the latter point and origin of the first dorsal. The dentition and other characters are as in the typical species.

The differential characters given in the foregoing diagnosis are considered of sufficient weight to warrant a specific separation between the form here described and its larger contemporary which accompanies it in the same locality, *S. alifera*. Not more than two or three examples of the latter form have thus far been brought to light, so far as published information goes, and the holotype of the recently described allied species is unique. Hence the genus *Squatina* must be regarded as having been represented very sparsely and by not more than three species at the time of its advent in the Upper Jura of Solenhofen.

7. **Squatina speciosa** H. von Meyer. (Plate LXVIII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 67.)

Several nearly perfect examples of this small ray are preserved in the Carnegie Museum, the Museum of Comparative Zoölogy at Cambridge, Massachusetts, and the British Museum. Those in the first-mentioned institution bear the catalog numbers 4052, 4053 (in counterpart) and 4054. One of them is noteworthy for displaying to excellent advantage, the contour of the body in the form of an impression but no new details are added to our previous knowledge of the species.

Family RHINOBATIDÆ.

"This family dates from the Upper Jurassic and is at present widely distributed, being represented by about five genera and twelve species. Most of these are inhabitants of tropical and subtropical seas." *Cf.* Cambridge Natural History, Fishes, p. 460.

Genus Rhinobatus Klein.

The nomenclature and synonymy of this genus, from which the family derives its name, is discussed by Garman in his memoir on the Plagiostomia published in 1913. Variously written as *Rhinobates*, *Rhinobatos*, and *Rhinobatus*, the establishment of the genus under the last-named style is credited by Garman to J. T. Klein, 1776, the type being fixed as *Raia rhinobatos* Linné, 1758. Most writers, following Müller & Henle, have ascribed the authorship of the genus to Bloch (*ed.* Schneider, 1801).

8. **Rhinobatus bugesiacus** (Thiollière). (Plate LXVI, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 78.)

"Snout produced and acute, the two rostral ridges narrow, and separated by a broad groove throughout their length. Cleft of mouth straight. Disk moderately broad; length of pectoral fin nearly 2½ times its breadth at the point of insertion. Skin covered with fine shagreen, without large tubercles or spines" (A. S. Woodward, Cat. Foss. Fishes, Part I, p. 78).

As first recognized by A. Smith Woodward, the type of the so-called *Spathobatis mirabilis* is only a large variety of this species. It is preserved in counterpart, one of the halves belonging to the Paleontological Museum in Munich, and the other to the Carnegie Museum (Cat. No. 5396).* This particular specimen is

* *Note by the Editor.*—This specimen has undergone and survived great dangers. One evening in Brussels, when the writer was engaged in packing up the collection of Baron Bayet for shipment to Pittsburgh, the hour being late, he gave orders that no more specimens should be brought down from

admirably preserved, and has become familiar to students through the published figure given in von Zittel's Handbuch; hence it is only necessary to record the fact that the counter-impression, which formed part of the Bayet Collection, is now to be seen on exhibition in the Carnegie Museum. Its sex is denoted by the pair of claspers.

The caudal portion of another large ray, probably referable to this species, is cataloged under the number 4409, and consists of about one hundred vertebræ retained in their natural position, together with portions of the endoskeletal cartilage, belonging apparently to the pelvic girdle. Neither dorsal nor caudal fins are preserved in this specimen, and only the posterior dorsal is shown in the counterpart of the Munich example.

Genus Belemnobatis Thiollière.

9. Belemnobatis sismondæ Thiollière. (Plate LXVII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 84.)

This species occurs typically in the Upper Jurassic of Cerin, France, and has not been previously reported from the Lithographic Stone of Bavaria. A single specimen from the latter locality, however, to be seen on exhibition in the Carnegie Museum (Cat. No. 4408), and remarkable for its perfect state of preservation, should undoubtedly be placed here. It measures 58 cm. in total length. The tail is spineless, and shows no indication of dorsal or caudal fins. The structure of the skull and nearly all of the endoskeletal parts are admirably displayed.

the upper floor of the *remise* where they were stored, and that work should cease for the day. Two of his overzealous assistants disobeyed, and, going up to the loft, attempted in the darkness to bring down this heavy and almost priceless slab. Descending the stairs in the dim light they stumbled and came rolling down the steps with their burden, which fell, and was shattered into scores of fragments upon the pavement of the lower court. The packers were instantly ordered from the spot, and sent away for the night. By the light of a lantern the writer, assisted by Dr. Eastman, working until nearly midnight, succeeded in gathering up the fragments, fitted them together, and then laying a large sheet of transparent paper over them made a careful tracing of their outlines, designating each piece by a number corresponding to numbers placed upon the tracing. On the following morning these pieces were carefully packed in cotton and together with the tracing were brought to America. With the outline before us, the writer, assisted by Mr. O. A. Peterson, succeeded in adjusting each bit to its place, and no one unacquainted with the fact, would imagine that at one time this noble specimen had lain a mass of comminuted fragments upon the pavement of a Belgian court-yard. It is in every way as good as if it had not been "smashed into smithereens." *W. J. Holland.*

Subclass TELEOSTOMI.

Order I. CROSSOPTERYGII.

Family CŒLACANTHIDÆ.

This family is remarkable among fishes for its conservatism and great longevity. From their first appearance in the Upper Devonian, the Cœlacanthidæ range practically unchanged through the intervening formations to the Upper Cretaceous. The most satisfactorily preserved remains are those obtained from the Lias and Upper Chalk of England, and from the Lithographic Stone of Bavaria. Those from the latter horizon have been exhaustively treated in a memoir by Dr. Otto M. Reis of Munich.[9]

Genus UNDINA Münster.

10. **Undina penicillata** Münster.

(For references to the synonymy see A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Part II, p. 410.)

Four well-preserved examples of this somewhat rare form are comprised in the Bayet Collection of the Carnegie Museum, and are cataloged under the following numbers: 4055, 4703 (in counterpart), 4791, and 4792. One of them is interesting because it shows the outlines of the ossified air-bladder, but none displays features not previously known.

Order HOLOSTEI (LEPIDOSTEOIDEI).

Family SEMIONOTIDÆ.

To this family belongs a series of deep-bodied forms represented by *Dapedius*, *Tetragonolepis*, *Homœolepis*, etc., which attain a notable development in the Lias, but become extinct with the last-named genus in the Upper Jura. But a solitary example of *Homœolepis* is known from Upper Jurassic rocks, and this is clearly indicative of a new species, the description of which follows:

Genus HOMŒOLEPIS Wagner.

A form in general resembling *Tetragonolepis*, but distinguished from it by the much less protuberant character of the ventral region, the relatively lower

[9] O. M. Reis, "Die Cœlacanthinen, mit besonderer Berücksichtigung der im Weissen Jura Bayerns vorkommenden Gattungen," Paleontographica, Vol. XXXV, 1888.

position of the pectoral fins, and by the greater number of scales in the vertical series below the vertebral axis. The pre-operculum is also much wider than in either *Dapedius* or *Tetragonolepis*.

The typical species is *H. drosera* (Egerton), from the Upper Lias of Wurtemberg, which by some authors is included in the same genus with *Tetragonolepis*.

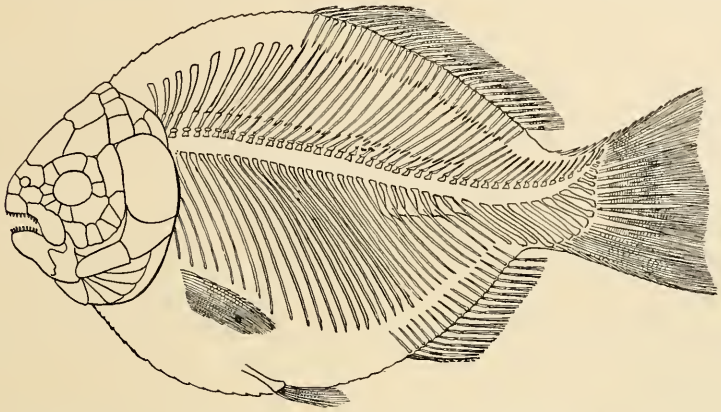

Fig. 2. *Dapedius politus* Leach. (After Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 131.)

The characters exhibited by the undermentioned species, which forms the terminal member of the group, may be regarded as confirming Wagner's recognition of this genus as distinct from *Tetragonolepis*.

11. **Homœolepis suborbiculata,** sp. nov. (Plate LVIII, fig. 3.)

Type.—Complete fish in counterpart; Carnegie Museum Cat. No. 4762, 4762*a*.

A large species attaining a length of about 33 cm. Maximum depth of trunk about equal to its length (exclusive of the caudal fin), and three and one-half times as great as the depth of the caudal pedicle. Head with opercular apparatus rather less than four times in the total length; the external bones almost smooth, with very few small sparse tubercles. Marginal teeth small, styliform, unicuspid. Pelvic fins arising midway between the pectorals and the anal; dorsal and fins each with about thirty rays, of which the more anterior ones are the most elevated, the dorsal fin being decidedly acuminate in front in consequence of this radial elongation.

Genus Lepidotus Agassiz.

12. **Lepidotus notopterus** Agassiz.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 92.)

This species is represented in the Bayet Collection of the Carnegie Museum by a single contorted individual, in which the squamation of the posterior part of the trunk is well displayed. It is cataloged as No. 697.

13. **Lepidotus ovatus,** sp. nov. (Plate LVIII, fig. 2.)

A species attaining a length of about 38 cm. and closely resembling *L. minor* in form and proportions, but with more strongly developed median fins, without dorsal ridge-scales, and the heavier squamation of the trunk arranged in more numerous longitudinal and transverse series. Flank-scales apparently smooth and not serrated. Fin-fulcra very large, those of the dorsal fin seven in number and more than half as long as the anterior dorsal fin-rays; those of the anal fin twelve in number and proportionally shorter. Pelvic fins arising midway between the pectoral pair and the anal, in this respect differing from the condition observed in *L. notopterus.*

The holotype and only known example of the species, the distinguishing characters of which have just been summarized, is a nearly complete fish, preserved chiefly in impression, which bears the catalog number 4730. It has a total length of 29 cm. to the base of the caudal fin, in which the length of the head with opercular apparatus is contained four times. The maximum depth of trunk is 11 cm. The number of oblique scale-rows counting along the lateral line is about forty, and of longitudinal scale-rows in the middle of the body about twenty-four.

Family MACROSEMIIDÆ.

Genus Ophiopsis Agassiz.

14. **Ophiopsis procera** Agassiz. (Plate LXX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 166.)

This genus and species was instituted by Agassiz upon the evidence of two incompletely preserved skeletons from the Lithographic Stone, one of which had a total length of about 30 cm. and the other of 10 cm. The smaller specimen was regarded by Agassiz as indicating an immature individual, and the larger as representing the full-sized or adult stage of the species. We here follow the procedure of Agassiz in referring to *O. procera* a small example measuring 14 cm. in total length, which bears the catalog number 4690. Another larger example in the collection is cataloged as No. 4691.

15. Ophiopsis tenuiserrata (Agassiz).

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 168.)

This species is represented in the collection by a single imperfectly preserved fish, in counterpart, having a total length of 17 cm., and cataloged as No. 5021 + 5021*a*.

16. Ophiopsis attenuata Wagner. (Plate LXII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 167.)

One excellently preserved example of this species is contained in the collection of the Carnegie Museum. It is cataloged as No. 4856.

Genus Histionotus Egerton.

17. Histionotus parvus Vetter.

1881. *Histionotus parvus* B. Vetter, Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 48, Pl. II, fig. 5.

Type.—Imperfect small fish; Dresden Museum.

The distinguishing specific characteristics of this form are enumerated by Vetter as follows: (1) its relatively small size; (2) its remarkably deep head and proportionally large size of the same; (3) its nearly vertical shoulder-girdle; and (4) the convex posterior margin and rounded inferior angles of the flank-scales. The holotype serving for Vetter's description exhibits a total length of 9.5 cm. and maximum depth of 3 cm., the depth of the head being 2.5 cm., and its length 2.7 cm. None of the median fins are preserved, but their position and general outlines are recognizable in the form of impressions. The dorsal fin is seen to be high and acuminate, extending for some distance over the middle of the back; the anal is pointed and remote, and the caudal fin is forked. The width of the caudal pedicle is contained two and a half times in the maximum depth. Teeth are not to be seen in the actual specimen, and according to the author the structures which are represented as such in the lithographic figure "verdanken ihre Entstehung der Phantasie des Zeichners."

So far as known the holotype of the species remains unique. Its characters are worthy of notice in this connection in order that the differences between it and the next following species may be more readily comprehended.

18. Histionotus reclinis, sp. nov. (Plate LXII, fig. 4.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 5002.

A small species, attaining a total length of about 10 cm., the length of the head with opercular apparatus being about equal to the maximum depth, and

contained slightly less than four times in the total length to the base of the caudal fin, which latter is scarcely forked and consists of about twenty-four rays. The short and low dorsal, with ten articulated rays, arises behind the middle point of the back, and the anal with fewer rays, is nearly opposite. Pectorals large, with about seventeen rays. Fulcra well-developed on all the unpaired fins. Scales in regular series, none especially deepened, posterior border nearly straight and strongly denticulated, the squamation extending over the upper lobe of the tail, and producing an upturned appearance of the latter. The specific title has reference to the last-mentioned character. Orbit large, high up; dentition not observed.

Genus Macrosemius Agassiz.

19. **Macrosemius rostratus** Agassiz. (Plate LXIII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 177.)

This species is represented in the collections of the Carnegie Museum by two excellent examples, cataloged under the numbers 4764, 4765.

20. **Macrosemius dorsalis,** sp. nov. (Plate LXV, fig. 2.)

Type.—Distorted fish; Carnegie Museum Catalog No. 4765.

A species of moderate size, attaining a total length of about 20 cm., in which the length of the head with opercular apparatus is contained about four times. Dorsal fin much elevated, and comprising about thirty-two rays, denticulated on their posterior borders, and somewhat expanded distally. Pelvic fins arising slightly in advance of the middle point between the pectoral and caudal fins, and the anal arising shortly behind. Exposed portion of the scales covered with fine striæ extending from the delicate pectinations of the posterior border.

This species, which is founded upon a unique, but somewhat crushed specimen from Solenhofen, approaches in certain respects the forms described from Cerin, France, by Thiollière; but is distinguished from them by the greater elevation of the dorsal fin, and the slenderer form of the rays, which are but little expanded distally.

Genus Propterus Agassiz.

21. **Propterus microstomus** Agassiz. (Plate LXII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 183.)

This elegantly formed fish is of comparatively rare occurrence in the Lithographic Stone of Bavaria, and has not been found elsewhere. No examples are contained in the collections of the British Museum, and but one, an exceedingly

perfect specimen in counterpart, in the Carnegie Museum. This is cataloged as No. 4468 + 4468*a*.

22. **Propterus speciosus** Wagner. (Plate LXIII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 184.)

Two nearly complete individuals in the collection are referable to this species. These are cataloged as numbers 4698 and 4825, and have a length of 12 cm. and 7 cm. respectively.

23. **Propterus conidens,** sp. nov. (Plate LXII, fig. 2.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4825.

A small species, attaining a length of about 10 cm. and maximum depth of 2.7 cm. Length of head with opercular apparatus contained nearly three times in the total length to the base of the caudal fin. Form of body elegantly fusiform, the dorsal and ventral borders gently arched, and width of the caudal pedicle a little more than half as great as the maximum depth of trunk. Fins as in *P. speciosus,* except that the dorsal fin is less elevated, its height falling considerably short of the maximum depth, and comprising apparently fewer rays. Caudal fin deeply forked. Scales finely denticulated.

The specific title is bestowed in allusion to the dental characteristics. The marginal teeth are sharply pointed, long and slender, and closely apposed to one another; as many as thirteen of them are to be counted along the rim of the jaw on one side.

Genus Notagogus Agassiz.

24. **Notagogus decoratus,** sp. nov. (Plate LXVIII, fig. 2.)

Type.—Well-preserved small fish; Carnegie Museum Cat. No. 5110.

Founded upon a unique specimen having a total length of 4.7 cm. Length of head with opercular apparatus exceeding the maximum depth of the trunk, and contained three times in the total length to the base of the caudal fin. Dorsal and ventral borders little arched, the trunk tapering very gradually toward the tail. Dorsal fin arising far forwards, its anterior portion comprising about fifteen rays, very widely spaced after the first three, which are closely approximated; second portion of the dorsal fin with about ten rays, also widely spaced with the exception of the first three; the rays of both portions gradually decreasing in length from the third or fourth ray onwards, and those of the anterior portion more elevated than those of the posterior portion; the longest fin-rays exceeding the maximum depth of trunk. Caudal fin slightly forked, comprising about sixteen rays, its margins

fringed with fulcra. Anal fin with seven rays; pelvics midway between the anal and the pectoral pair; the latter comprising about twelve much elongated rays. Scales thin, with five or six very long and sharp denticulations along the posterior border, and covered with exceedingly delicate horizontal striations on the inner surface. Teeth minute.

The holotype of this species is shown from the left lateral aspect in Plate LXVIII, Fig. 2, somewhat larger than natural size. A portion of the squamation having adhered to the opposite half of the containing matrix, the scales are seen from the inner side in the only part of the specimen which is now preserved. They are semitranslucent, and the remarkably strong denticulations are visible through the thickness of the overlapping series.

Family PYCNODONTIDÆ.

Genus Mesodon Wagner.

25. **Mesodon macropterus** (Agassiz). (Plate LXI, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 199.)

This species is represented in the collection of the Carnegie Museum by two relatively large-sized individuals (Cat. Nos. 4733, 4891), which measure about 22 cm. in total length, but are slightly injured in the region of the head; also by a

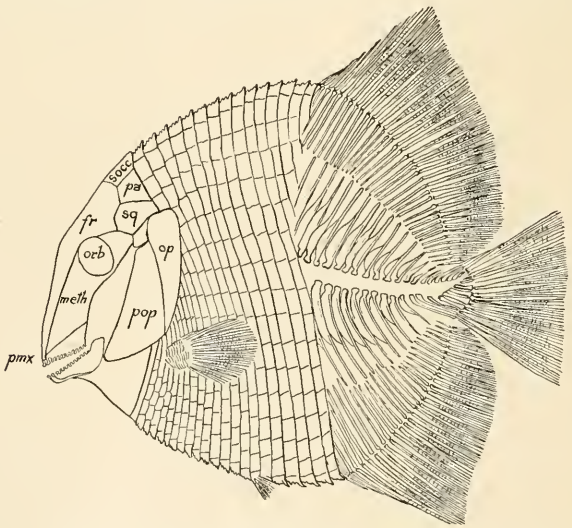

Fig. 3. *Mesodon macropterus.* (After A. S. Woodward, "Outlines of Vertebrate Paleontology," p. 105, 1898, fig. 74.)

very small specimen in counterpart (4456, 4456*a*), which is perhaps to be regarded as indicating a dwarf variety. The subjoined restoration of this species (Fig. 3) is copied from A. Smith Woodward.

Genus Gyrodus Agassiz.

"Trunk deeply fusiform or discoidal, with a slender abbreviated caudal pedicle. Head and opercular bones ornamented with tubercles; cheek and gular region covered with small, imbricating cycloidal scales; teeth more or less rugose and mammillated, those of the vomer in five, and those of the splenial in four regular series. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the notochord. Fin-rays robust, closely arranged, articulated, and divided distally. Pelvic fins present; dorsal and anal fins low and fringe-like, except in front where they rise to an elevated point, these two fins arising at about the same point and not extending in advance of the hinder half

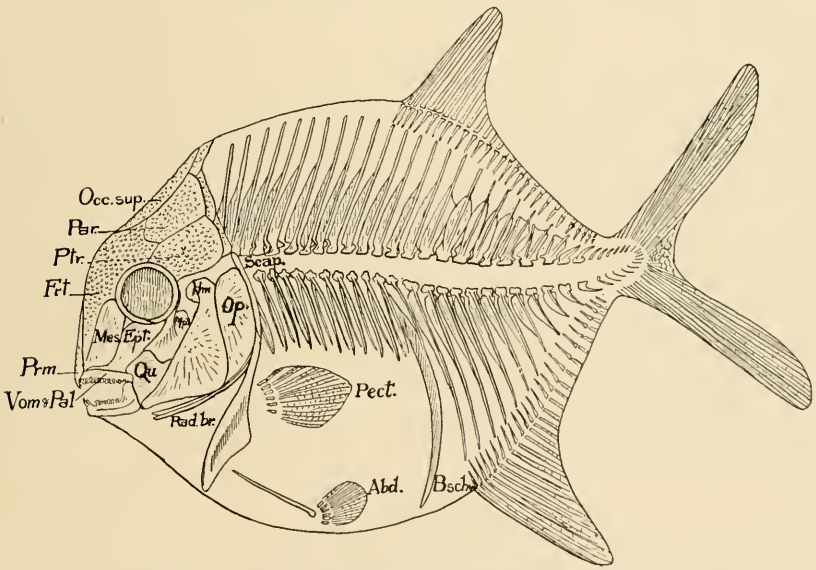

Fig. 4. *Gyrodus hexagonus* (Blainville). (After E. Hennig in "Palæontographica," Vol. LIII, 1906, Pl. XI, fig. 2.)

of the trunk; caudal fin deeply forked, with slender lobes. Scales tuberculated or rugose, covering the whole of the trunk" (A. S. Woodward, *l. c.*, Pt. III, p. 233).

26. **Gyrodus macrophthalmus** Agassiz. (Plate LXIX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 233.)

This species is represented in the collections of the Carnegie Museum by a well-preserved individual having a total length of 25 cm. (No. 4734) showing the characteristic scale-markings and part of the dentition. Hennig's proposal to suppress this, the type-species, and also *G. frontatus*, in favor of Blainville's term, *G. hexagonus*, cannot be sustained.

27. **Gyrodus frontatus** Agassiz. (Plate LXI, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 235–6.)

A species, so far as known, closely similar to the type, only differing in the relatively greater protuberance of the abdominal region, in the simple mammillation of the teeth, and in having the tubercular ornamentation of the scales without reticulations, extending over the ventral half of the fish (*cf.* A. S. Woodward, *l. c.*, Pt. III, p. 236).

This form is well represented in the collections of the Carnegie Museum, the examples belonging to it being cataloged as follows: 10, 690, 691, 3003, 4685, 4735 (in counterpart), 4736, 4763 (in counterpart), 4796, 4797 (in counterpart), 4798 (in counterpart), 4799, 4893. The figure on Pl. LXI is unfortunately reversed.

28. **Gyrodus circularis** Agassiz. (Plate LXIX, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 238.)

A magnificent example of this species, having a total length of 75 cm., forms one of the most attractive exhibits of fossil fishes to be seen in the Hall of Vertebrate Paleontology in the Carnegie Museum. It is cataloged as 4407*x*. Another specimen (Catalog Number 4407), of even larger size shows the well-preserved squamation of the left side of the trunk.

Family EUGNATHIDÆ.

Genus EUGNATHUS Agassiz.

29. **Eugnathus longiserratus** (Agassiz). (Plate LXIV, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 301.)

Three well-preserved specimens referable to this species form part of the exhibition series of the Carnegie Museum, and are cataloged under the numbers 4686, 4719 (in counterpart), and 5021 respectively.

Genus Caturus Agassiz.

30. **Caturus furcatus** Agassiz. (Plate LIX, fig. 3; Plate LX, fig. 2; Plate LXI, figs. 4 and 5; Plate LXVIII, fig. 1; Plate LXXII, fig. 3; Plate LXXXIII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 332.)

This, the typical species, is of common occurrence in the Lithographic Limestone of Bavaria and the Department of Ain, France; and, owing to its abundance and favorable state of preservation, nearly all details of its skeletal organization are accurately known. An excellent restoration is given by Dr. A. S. Woodward in his Catalog, Pt. III, p. 331, fig. 36. A view of the underside of the head of a specimen (No. 4451) is given on Plate LXVIII, fig. 7.

In the opinion of Dr. A. S. Woodward, various small forms of *Caturus*, which have been described under different specific titles, are to be regarded as immature examples of the type species, *C. furcatus*. As shown by comparison of a large series of specimens, the latter is no doubt represented in the Lithographic Stone by several well-marked varieties, which appear, nevertheless, to grade into one another, and for that reason can scarcely be separated into species clearly distinguishable from the type. It is more expedient, therefore, to group them all under one head, in which case the trivial names *C. macrurus*, *microchirus*, *obovatus*, *ferox*, and *gracilis* become synonyms of *C. caturus*. From the large suite of material belonging to the Carnegie Museum several well-preserved examples have been chosen for illustration in the present Memoir, among them one of the small varieties which was named by Agassiz *C. macrurus*. This is shown in Plate LXI, fig. 4. The remaining specimens in the collection are cataloged as follows: 696, 866, 871, 872, 4028, 4451, 4697, 4699, 4713, 4720, 4721, 4723, 4771, 4774, 4778, 4790, 4795, 4808, 4809, 4809*a*, 4859, 4861, 5013, 5014, 5020, 5049, 5053.

31. **Caturus pachyurus** Agassiz. (Plate LIX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 336–7.)

This is a much rarer form than the type species of *Caturus*, and is represented in the collections of the Carnegie Museum by a single well-preserved specimen, which bears the catalog number 4724, and is shown on Plate LIX.

Family AMIIDÆ.

Genus Megalurus Agassiz.

32. **Megalurus lepidotus** Agassiz. (Plate LXX, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 36.)

Only two examples of this early Amioid species are listed in Dr. Smith Woodward's Catalog as belonging to the British Museum. The Carnegie Institute is fortunate in possessing a number of well-preserved specimens, catalogued as follows: 4732, 4767, 4768, 4769, 4812, and 4862. The first four are in counterpart.

33. **Megalurus elegantissimus** Wagner. (Plate LXX, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 365.)

The following numbered examples in the Carnegie Museum are referable to this species: 693, 4854.

Family PACHYCORMIDÆ.

Genus Sauropsis Agassiz.

34. **Sauropsis longimanus** Agassiz.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 375.)

This is an extremely rare form, occurring, so far as known, only in the Lithographic Stone of Bavaria, though a closely related species, as yet undescribed, is reported by A. Smith Woodward from the Oxfordian of Wiltshire. Neither the Carnegie nor the British Museum possesses examples of the species.

35. **Sauropsis depressus,** sp. nov. (Plate LX, fig. 3.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4766 + 4766*a*.

Form of body slender and elongate, the length of head with opercular apparatus considerably exceeding the maximum depth of trunk. Pelvic fins arising midway between the pectorals and the anal; dorsal fin arising opposite the low fringe-like posterior portion of the much extended anal, and consisting of comparatively few rays; the anterior rays of the dorsal and anal equal in elevation, but rapidly decreasing posteriorly. Other characters similar to those of the type species.

The holotype of this extremely slender species is a well preserved skeleton having a total length of about 32 cm., in which the trunk is exhibited from the lateral, and the head, which is reflexed, from the ventro-lateral aspect. It is in counterpart, and the skeletal structure can be studied in its entirety by combining both halves. In the type specimen of *S. longimanus* figured by Agassiz the head

is shown in profile, thus affording a tolerably clear idea of the arrangement of the cheek and opercular plates, but yielding no information as to the covering of the thoracic region; the present specimen, on the other hand, completes our knowledge of the underside of the head, and displays besides the branchiostegal and opercular apparatus to excellent advantage.

The anterior portion of the space between the mandibular rami is completely covered by a narrow, triangular gular plate, behind which occur the closely spaced series of branchiostegal rays, these latter being in juxtaposition superiorly with the angular element, interoperculum, and suboperculum in ascending order. In the thoracic region the interspace between the divergent series of branchiostegal rays is occupied apparently by a single, thin, delicate plate, which probably owes its origin to the fusion of a number of small scales. The structure of the mandible is not altogether clear, but the splenial is evidently a long delicate plate, beset with small conical teeth, while the angular occupies about one-third of the outer face of the ramus. The maxilla is long and slender, tapering in front, deepest behind, and in its middle portion is in contact with the sclerotic ring, which is ossified. The latter is apparently bounded posteriorly by a ring of small circumorbitals, the boundaries between which have become obliterated.

With regard to the structure of the fin in the type-species Agassiz remarks as follows: "Les nageoires reflètent en quelque sort à l'extérieur cette forme grêle du squelette, car leurs rayons sont tous sans exception excessivement fins: Les pectorales qui ont valu à l'espèce son nom sont très-developpées, fort longues, et en même temps très-larges. Les plus grands rayons débordent beaucoup l'insertion des ventrales. Autant les pectorales sont grandes, autant les ventrales sont petites."

These characters of the paired fins hold true for the new species under discussion, as well as for the type, the only difference being that the pectoral fin-rays are more numerous in the present form than in *S. longimanus*. Upwards of forty are to be counted in the specimen now in hand, and although Agassiz does not state the number observed by him in *S. longimanus*, only half as many are shown in the published illustration (Poiss. Foss., Vol. II, Pl. LX). The median fins are essentially alike in the two species, except for the more remote position of the dorsal in the example here made the type of a new species, as already noted. The caudal fin is most exquisitely preserved, and shows the upward prolongation of the axis for a short distance into the superior lobe. The scales and internal skeletal structure do not call for particular mention.

36. **Sauropsis curtus**, sp. nov. (Plate LXVI, fig. 1.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4772.

Form of body deeper and more compact than in other known species, the trunk relatively short and tapering rapidly posteriorly, the width of the caudal pedicle equalling about one-third of the maximum depth. Length of head with opercular apparatus equalling maximum depth, and contained nearly four times in the total length to the base of the caudal fin. Form and position of the fins as in the type species (*S. longimanus*), except that the pectoral pair is less strongly developed, and the rays of all the fins show articulations throughout their entire length. Dorsal fin-supports about thirty, and anal fin-supports about fifty in number, all more closely spaced than the neural and hæmal spines. Number of the latter upwards of ninety from the anterior portion of the axis to a point underneath the hinder extremity of the dorsal fin, and their total number estimated to have been about one hundred and twenty-five. Lateral line conspicuous, parallel with the axis, and continued over the parieto-frontal bones of the head. Operculum subtriangular and much deepened; pre-operculum narrow and elongate, in contact through its entire length anteriorly with the vertically elongate postorbital. Snout obtuse; dentition as in the type-species.

The holotype answering to the above description is a magnificently preserved specimen, having a total length of about 28 cm., and of very great importance on account of the perfection with which the cranial and facial elements are displayed. A remarkable feature is the great elongation in a vertical (transverse) direction of all of the parts lying between the postorbital and posttemporals. The postorbital itself occupies the space which in the existing *Amia* is covered by a distinct portion of the integument overlying the pre-operculum and extending forward to the angle of the jaws.

Genus Hypsocormus Wagner.

37. **Hypsocormus insignis** Wagner. (Plate LXXI, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 391.)

An exceptionally perfect example of this species (No. 5398) having a total length to the base of the caudal fin of 53 cm., and displaying all of the fins and skeletal parts to advantage, is to be seen on exhibition in the Hall of Fossil Vertebrates in the Carnegie Museum. The pectoral fin-rays are stouter and more numerous than are shown in A. S. Woodward's restoration of this species, and the supports for the anal are somewhat longer. For purposes of comparison the figure given by Woodward is here reproduced.

An interesting structure not hitherto observed in connection with this species is the presence of a long and tapering air-bladder, the calcified walls of which show a series of transverse ridges not unlike those formed by muscle-fibres in modern Ganoids and Dipnoi. Confluent with the intestinal tract in front, the organ in question extends longitudinally close to the ventral body-wall along one side of the supports for the anal fin, and terminates in a closed sac immediately behind the latter.

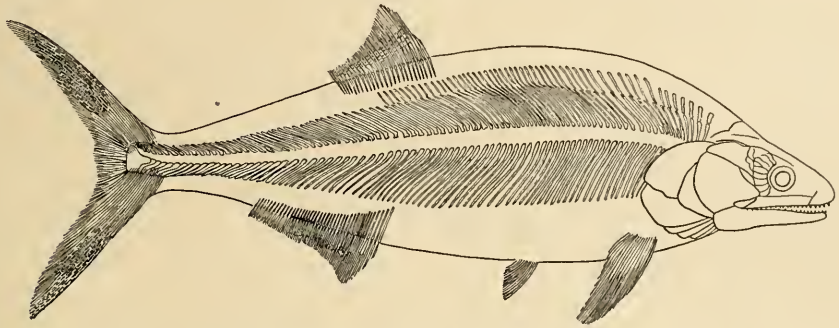

FIG. 5. *Hypsocormus insignis* Wagner. (After A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, fig. 40, p. 393.)

Somewhat similar structures have been observed in *Pachycormus* and *Asthenocormus*, and are interpreted in the latter by B. Vetter as spiral valves of the intestine (*cf. infra*, p. 461). The numerous internal septa ("convolutions" of Vetter), small size of the organ, and its prolongation into the region posterior to the anal fin, are characters which militate against this view of its nature. For the suggestion that the structure in question is a calcified air-bladder the writer is indebted to his friend, Dr. C. H. Eigenmann, than whom no one is better qualified to pass judgment upon the actual specimens submitted for examination.

According to this eminent authority, the form and position of the air-bladder exhibit a wide range of variation among closely related genera of modern teleosts, even within the limits of a single subfamily, such as the Curimatinæ[10] of the Characidæ or Sternopyginæ[11] among the Gymnotidæ.

[10] Eigenmann, Carl H. and R. S., "A Revision of the Edentulous Genera of Curimatinæ," Annals N. Y. Acad. Sci., 1889, Vol. IV, pp. 409–440.

[11] Ellis, Max Mapes, "The Gymnotid Eels of Tropical America," Mem. Carn. Mus., Vol. VI, No. 3, 1913, pp. 186–189.

38. **Hypsocormus macrodon** (Wagner). (Plate LXXI, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 394.)

Two representatives of this species occur in the collections of the Carnegie Museum, both of large size and well-preserved, and both on exhibition in the Hall of Fossil Vertebrates. One, having a total length of about 65 cm., is preserved without any distortion other than vertical crushing, and displays the head-parts and all the fins in very nearly their entirety. The other, which is more than twice the size of the first, is contorted in such manner that the body is coiled upon itself, the head and inferior caudal lobe being closely approximated. The relatively short head, with its large, forwardly placed orbit, together with the slender and elongate form of body, terminating in a widely expanded caudal fin, give to this species a characteristic expression. The bones of the head are finely tuberculated, and the scales delicately striated. The ventral fins are situated midway between the pectorals and anal fin. To this species may also be referred an imperfect detached head, cataloged as number 4794.

Genus Asthenocormus A. S. Woodward.

39. **Asthenocormus titanius** (Wagner).

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 380.)

Of this species, one of the largest of Jurassic Pachycormidæ, only two tolerably complete individuals are known, the holotype which is in Munich, and the interesting specimen studied by Vetter, which belongs to the Dresden Museum. In neither specimen is the dentition satisfactorily shown, nor is any trace preserved of the pelvic fins. Nevertheless there is reason to believe that the latter organs were present, and that a series of enlarged prehensile teeth was borne anteriorly by the jaw-parts. Such, at least, are among the characters which have been observed in the case of the next following species.

Mention should be made in this connection of a peculiar structure described by Vetter in the example studied by him, the significance of which would seem to have been misinterpreted. The position of the stomach and intestinal tract is clearly indicated in the specimen belonging to the Dresden Museum and according to the author just named, the intestine is provided posteriorly with a remarkably well-developed spiral valve. The small diameter of this tube, its tapering posterior extremity and total absence of coprolitic matter in its interior, are features difficult to reconcile with the view that we here have to do with a much convoluted spiral valve. A more plausible interpretation is to regard it as a calcified air-bladder

similar to that already observed in *Hypsocormus*, and the convoluted appearance of which is due to the presence of numerous transverse fibrous bands and ridges. From analogy with recent forms in which similar bands occur, it may be presumed that the interior was partitioned off by transverse septa extending between the ridges.

40. **Asthenocormus retrodorsalis**, sp. nov.

Type.—Imperfect fish; Carnegie Museum (Cat. Nos. 4863, 4863*a*, 4863*b*).

A species nearly equalling the type of the genus in size, and resembling it in general form and proportions, but distinguished from it chiefly by characters of the median fins and the dentition. Pelvic fins present, and the low triangular dorsal fin arising behind the anal.

This species is established upon the evidence of a single nearly complete individual, preserved in counterpart, from the Lithographic Stone of Kelheim, Bavaria, and contained in the Bayet Collection of the Carnegie Museum. The head and anterior portion of the trunk have been considerably crushed and deformed, but the remainder of the body is preserved without distortion and shows the lateral aspect, the position of all the fins being clearly indicated.

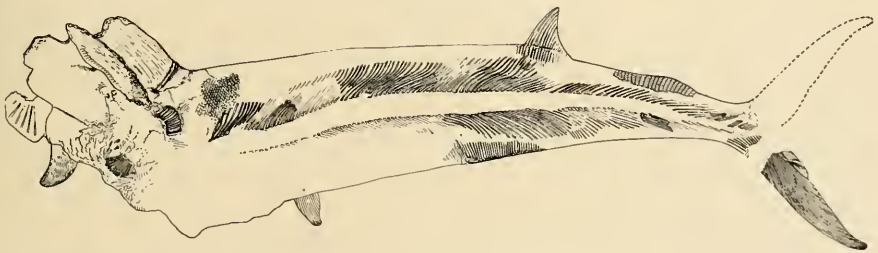

Fig. 6. *Asthenocormus retrodorsalis*, sp. nov. C. M. Cat. Foss. Fishes, Nos. 4863 and 4863*a*. × ⅓.

As denoted by the specific title, the dorsal fin is remote, arising behind the origin of the anal, and is much shorter than the latter. The dorsal fin consists of comparatively few rays, which posteriorly rapidly decrease in size. The anal fin has become detached, but its internal supports are preserved intact; these depend almost vertically from the hæmal spines, and are seen to be about thirty in number. The small pelvic pair is situated midway between the pectorals and anal fin. The proximal portions of both pectorals are preserved, but the distal two thirds have been broken away. The caudal fin is complete, exhibiting the very fine subdivision of the rays at its hinder border, but no fulcra along the anterior margin.

New and interesting features are presented by the dentition of this species.

Teeth are not preserved in either of the containing slabs which display nearly the entire body of the fish, but are found associated with some of the opercular plates and jaw-parts which have been fractured off from the main portion of the fossil, the whole mass being embedded in a separate block of limestone which evidently lay in juxtaposition with the two larger slabs.* It is difficult to identify all of the plates which are found partly overlying one another and forming a more or less confused mass in this smaller block of limestone, but it is evident at a glance that other elements bordering the mouth-cavity besides those in direct relation with the jaws were dentigerous. Small, recurved conical teeth were probably borne on the entire palatal roof, including the pterygoids and parasphenoid, and some may have lined the throat cavity, as is perhaps to be inferred from the occurrence of numerous small conical teeth in clusters, which show no signs of havingbeen embedded at the base in alveolar sockets and can scarcely be considered as jaw-teeth.

As regards form and mode of occurrence, the teeth just described agree closely with the conditions noted by Vetter in two individuals of the type-species studied by him. This will appear from the following passage which is extracted from the account of the dentition of *A. titanius* given by the author just named.[12]

* Since Dr. Eastman wrote these lines the Director has had the specimens carefully examined, with a view to ascertaining possible points of contact between the pieces embedded in the plaster mount. This work was very carefully done by Mr. O. A. Peterson. It is now discovered that the upper caudal lobe of the specimen in both slabs is very ingeniously made out of plaster of Paris. Whether it is possibly a cast made from fragments, which were not preserved, and for which this plaster of Paris reproduction was substituted, it is not now possible to say. The examination made shows that, as restored by the original collector, he was careless in noting the contacts, with the result that the lower lobe of the caudal as placed was quite too near the vertebral column, a piece containing the fulcra evidently having been dropped out.

Figure 6, which has recently been made by Mr. Prentice, shows the exact facts as to the caudal lobes.

In reference to the head (4863*b*) which has been associated by Dr. Eastman with the specimen, it must be said that this association is not determinable by any contacts which can be discovered in the anterior parts of either of the larger slabs containing the body of the fish. All the plaster has been removed and a diligent search has been made for contacts, but none are discoverable. If it belonged to the larger blocks, it must have been lying at some remove from the rest of the body of the fish. There is a presumption in favor of its having been a part of this specimen, arising from the color and composition of the matrix. Unfortunately Baron Bayet does not appear to have always appreciated the importance of preserving exact records as to the origin of specimens, and we have no clue in any list of purchases made by him, or any of his correspondence, which is in our hands, which would serve to establish the fact that the head and the body associated by Dr. Eastman belonged together. This association, while it appears plausible, nevertheless does not rest upon evidence which is incontestable.

W. J. Holland.

[12] Vetter, Benjamin. Die Fische aus dem lithographischen Schiefer im Dresdener Museum (Mittheil. K. Mineral-Geol. Museum Dresden, 1881, Pt. IV, p. 99).

"Die Zähne zeichnen sich weder durch Farbe oder Glanz, noch durch Grösse aus, und sind nur mit Mühe herauszufinden. Sie liegen zerstreut, theils ganz vorn, besonders aber vor, unter und hinter dem Auge, ihre Spitze meist nach oben und vorn, zum Theil auch nach unten gekehrt; alle diese mögen noch auf den Kieferrändern gesessen haben. Nun folgen, aber, durch das Operculum hindurch sichtbar, zahlreiche bis zu seinem Hinterrande reichende Zähne, welche noch am ehesten eine regelmässig senkrechte Lage zeigen; diese müssen am Parasphenoid und an den gegenüber liegenden Flächen der Basibranchialia resp. der Schlundknochen befestigt gewesen sein. In der That bemerkt man denn auch an der mitten durch das Auge ziehenden Strecke des ersteren gleichfalls eine Anzahl kleiner Zähne.

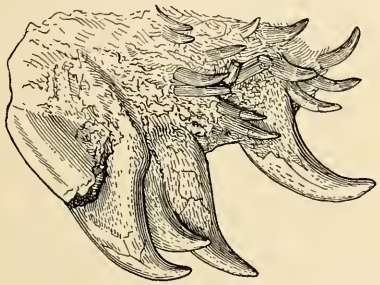

FIG. 7. *Asthenocormus retrodorsalis*, sp. nov. Anterior dentition. C. M. Cat. Foss. Fishes, No. 4863*b*. × ½.

"Alle diese Zähne sind meist schwach gekrümmt, sehr spitz und schlank bis plump kegelförmig, mit glatter Oberfläche. . . . Da sie überall nur in grösserer Anzahl beisammenliegen, so scheinen sie auch auf den Kieferrändern nicht in einfachen Reihen, sondern nach Art von Bürstenzähnchen gruppenweise gesessen zu haben (im ganzen damit übereinstimmend ist das sporadische Vorkommen von Zähnen bei Exemplar II)."

So far the dental characters of the type-species are seen to stand in perfect accord with those of the new form now under discussion. That which is altogether novel, however, and in fact unique among the *Pachycormidæ*, is the presence of a series of enlarged teeth with laterally compressed bases, situated at the front margin of the upper and lower jaws and extending also, as far as one may judge from their position in the matrix, for some distance posteriorly along the outer rim of the jaws. The form of these enlarged prehensile teeth recalls in a general way the compressed broad-based teeth which have been provisionally named *Ancistrodon*, except that the crown is more elevated, conical, and regularly arched. Some of them, also, appear to have had very deep roots. Figures of these prehensile

teeth are given in the accompanying illustration (Fig. 7.) This peculiar differentiation of the dentition in *Asthenocormus* is most nearly approached among kindred forms by the Cretaceous *Protosphyræna*, in which the more anteriorly placed teeth are especially large, much compressed, and implanted in deep sockets. In respect to various characters, the genera *Pachycormus, Hypsocormus, Asthenocormus* and *Protosphyræna* represent, in the order named, successive stages of modification, at the same time closely mimicking in general form of body the Tertiary Xiphiidæ or "sword-fishes."

Family ASPIDORHYNCHIDÆ.

Genus Aspidorhynchus Agassiz.

In this genus, according to Dr. A. S. Woodward, the vertebral centra are always in the form of delicate rings, each bearing its own arch. The ribs are very short and thin. In the abdominal region the neural spines appear to be separate from their supporting arches, though this is not quite certain; in the caudal region, both hæmal and neural spines are fused with their arches, and the latter with their respective centra. As might be expected from the stout proportions of the rays, the supports for the dorsal and anal fins are especially robust; and they are shown to be more numerous than the vertebral segments beneath them. The scales are all thick and rhombic, strengthened by a slight internal median rib, and those of the flank united by a large peg-and-socket articulation. The lateral line pierces each scale it traverses.[13]

41. **Aspidorhynchus acutirostris** (Blainville). (Plate LXIV, fig. 3.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 419.)

This species is represented in the collections of the Carnegie Museum by a number of fine examples, certain of which are to be seen on exhibition in the Hall of Fossil Vertebrates. The complete suite of specimens is cataloged as follows: 12, 14, 4741, 4743, 4774, 4745, 4746, 4777 + 4777*a*, 4779, 4810, 4823, 4814, 4864, 4867, 4868 + 4868*a*.

Genus Belonostomus Agassiz.

42. **Belonostomus muensteri** Agassiz. (Plate LX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, pp. 429–30.)

This species is represented in the collection of the Carnegie Museum by the following examples: Cat. Nos. 4115, 4795, 4796, 4850, 4865, 4866.

[13] For a description of the cranial osteology and other interesting details of the structure of two species of *Aspidorhynchus* reference may be made to Assmann's paper "Ueber Aspidorhynchus" in *Archiv für Biontologie* 1906, Bd. I, Heft 1, pp. 49–80.

Suborder *ISOSPONDYLI*.

Family PHOLIDOPHORIDÆ.

Genus Pholidophorus Agassiz.

43. **Pholidophorus macrocephalus** Agassiz. (Plate LVIII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, pp. 467–8.)

The synonymy of this species, as given by A. S. Woodward, agrees with the conclusions of Wagner and Vetter, excepting that the latter has proposed the trivial name *P. magnus* to designate the species, a procedure which is contrary to recognized codes of nomenclature. The following examples in the Carnegie Museum are referable to this species: Car. Mus. Cat. Nos. 694, 4793, 4811, 4898, 5067, 5087.

Family OLIGOPLEURIDÆ.

Genus Œonoscopus Costa.

(Syn. *Attakeopsis* Thiollière; *Macrorhipis* Wagner.)

44. **Œonoscopus cyprinoides** (Wagner). (Plate LXV, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 495.)

Two well-preserved individuals belonging to this species are contained in the Bayet Collection, and are cataloged under the following numbers: 4700, 5086. Examples of this species are rare in the Lithographic Limestone.

Family LEPTOLEPIDÆ.

Genus Leptolepis Agassiz.

45. **Leptolepis dubia** (Blainville).

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 509.)

This and the closely related *L. sprattiformis* are among the commonest fishes occurring in the Lithographic Stone of Bavaria, and both are abundantly represented in the collections of the Carnegie Museum, many of the specimens being remarkably well preserved, and displaying nearly the entire cranial and skeletal osteology. To the species under consideration belong the following examples: Carnegie Mus. Cat. Nos. 9, 13, 4448, 4687, 4693, 4694, 4695, 4712, 4714, 4715, 4782, 4783, 4784, 4785, 4786, 4801, 4803, 4804, 4805, 4806, 4807, 4820, 4821, 4822, 4831, 4832, 4838, 4839, 4840, 4841, 4842, 4873, 4871, 4875, 4895, 5000, 5004, 5005, 5010, 5011, 5012, 5019, 5027, 5028, 5029, 5030, 5031, 5032, 5033, 5035, 5040, 5041,

5044, 5065, 5069, 5070, 5075, 5089, 5090, 5091, 5092, 5093, 5094, 5095, 5096, 5101.

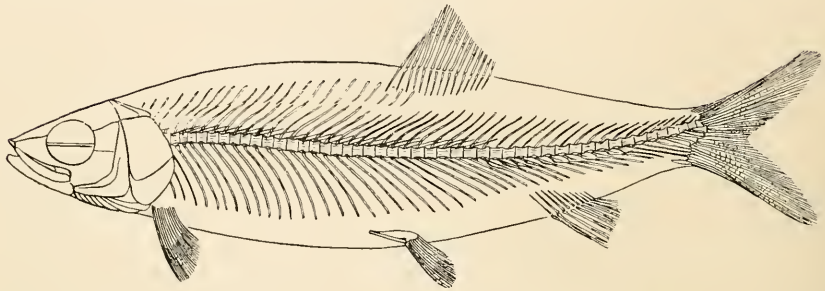

Fig. 8. Restoration of *Leptolepis dubia*. (After A. S. Woodward.)

46. **Leptolepis sprattiformis** (Blainville). (Plate LXXIII, figs. 1–3.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 513.)

The following examples in the Carnegie Museum are referable to this species: Car. Mus. Cat. Nos. 861, 863, 864, 4030, 4031, 4107, 4108, 4109, 4110, 4111, 4112, 4114, 4116, 4117, 4118, 4119, 4120, 4121, 4122, 4123, 4124, 4125, 4126, 4128, 4149, 4242, 4243, 4244, 4246, 4247, 4249, 4251, 4252, 4253, 4254, 4255, 4256, 4258, 4260, 4261, 4262, 4263, 4264, 4417, 4665, 4815, 4834, 4835, 4877, 4878, 4879, 4880, 4881, 4882, 4883, 5007, 5009, 5006, 5024, 5025, 5026, 5043, 5047, 5048, 5059, 5062, 5063, 5064, 5082, 5084, 5104, 5106, 5113.

Genus Æthalion Münster.

47. **Æthalion knorri** (Blainville). (Plate LXXIII, fig. 4.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 518.)

This species is not particularly common in the Upper Jura of Solenhofen, and is represented in the collections of the Carnegie Museum by a number of examples, which bear the following catalog numbers: 865, 4688, 4689, 4800, 4830, 4837, 4843, 4845, 4846, 4852, 4869, 4870, 4872 + *a*, 4889, 4897, 5003, 5008, 5017, 5022, 5023, 5034, 5038, 5039, 5042, 5045, 5046, 5051, 5057, 5066, 5071, 5077, 5079, 5099.

Genus Thrissops Agassiz.

This is one of the more abundant genera in the Lithographic Limestone of France and Bavaria, and is represented in the Solenhofen fauna by three species, of which the following is the most important:

48. **Thrissops formosus** Agassiz. (Plate LXII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 521.)

A large series of *Thrissops* belonging to this species are contained in the Bayet Collection of the Carnegie Museum, several complete and admirably preserved individuals being among the number. These specimens bear the following catalog numbers: 4030, 4702, 4789.

49. **Thrissops salmoneus** (Blainville). (Plate LXXII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 522.)

This species is represented in the collection by specimens bearing the following numbers: 870, 4717, 4773, 4813, 4818 + *a*, 4894, 5088, 5090.

Genus Parathrissops *novum*.

A genus resembling *Thrissops* in general characters, but distinguished from it by its relatively much shorter and compact form of trunk, and by the more anterior position of the dorsal fin, which arises somewhat in advance of the anal and is not much extended. Anal relatively shorter than in *Thrissops*.

50. **Parathrissops furcatus** sp. nov. (Plate LIX, fig. 2.)

Type.—Nearly complete fish in counterpart; Carnegie Museum Cat. No. 4029 + 4029*a*.

The type and only known species, attaining a total length of about 23 cm. Head with opercular apparatus contained four and one-half times in the total length of the fish; maximum depth of trunk equalling the length of the head with opercular apparatus, and contained a little more than two and one-half times in the length of the trunk from the pectoral arch to the base of the caudal fin. Vertebræ about forty-four in number, half of them being abdominal, and half caudal. Pelvic fins arising but little nearer to the anal than to the pectorals; dorsal fin, with fifteen rays, arising somewhat in advance of the origin of the anal, which is much elevated in front, and comprises about twenty-two rays; caudal fin deeply forked and with expanded lobes. Scales thin, ornamented with exceedingly delicate concentric striæ.

The holotype of this species is an admirably preserved individual having a total length of 23 cm. and depth of 5 cm. It is readily distinguished from all other species by the form and proportions of the body and more forward position of the dorsal fin, together with the deeply furcate and broad-lobed character of the caudal.

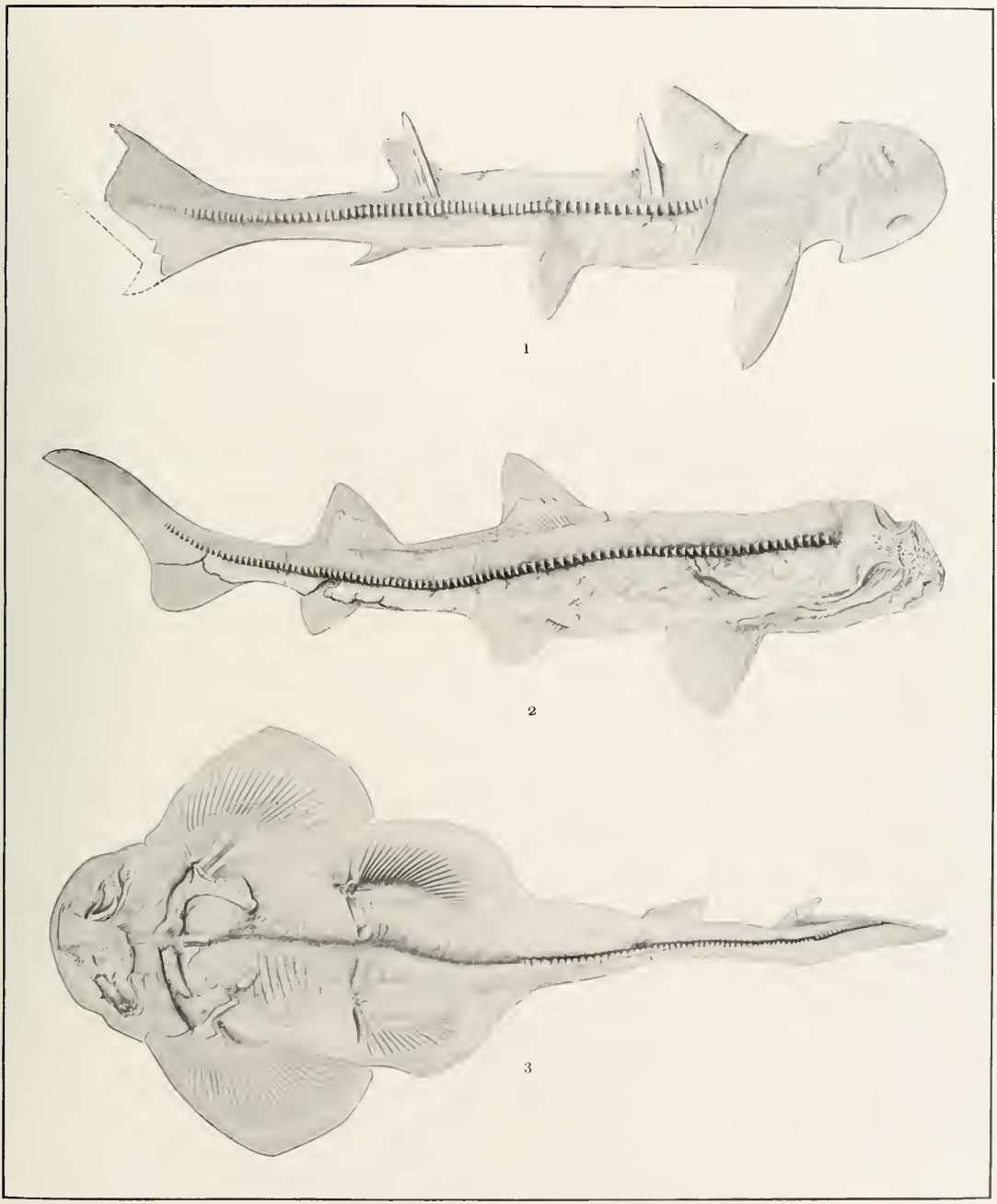

FIG. 1. *Cestracion zitteli* EASTMAN. C. M. CAT. FOSS. FISHES, NO. 4423. (SLIGHTLY ENLARGED.)
FIG. 2. *Phoreynis catulina* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, NO. 4780. × $\frac{26}{100}$.
FIG. 3. *Squatina minor* EASTMAN. C. M. CAT. FOSS. FISHES, NO. 4737. × $\frac{31}{100}$.

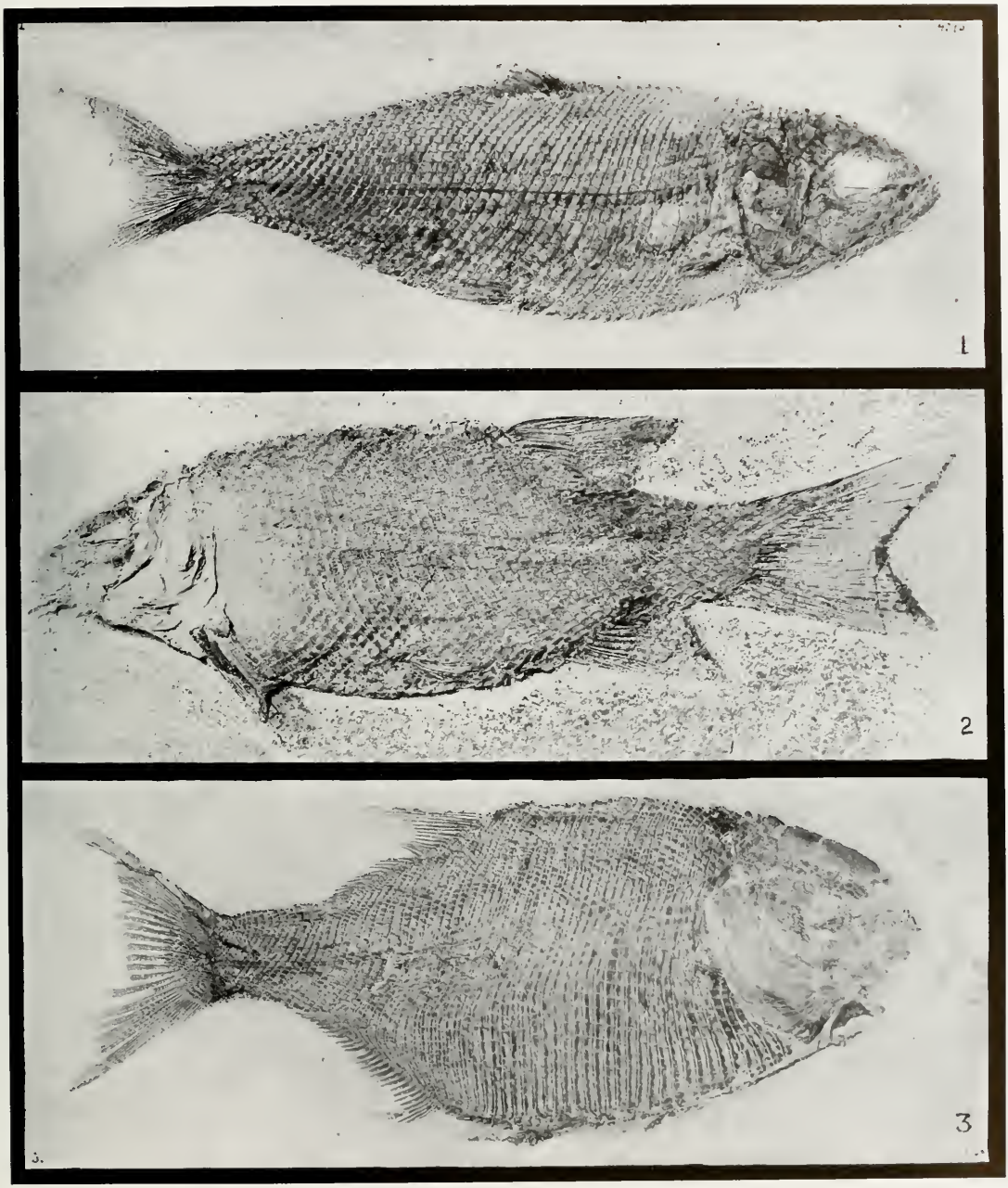

FIG. 1. *Pholidophorus macrocephalus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4793 (227 MM.).
FIG. 2. *Lepidotus ovatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4730 (372 MM.).
FIG. 3. *Homœolepis suborbiculata* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4762 (410 MM.).

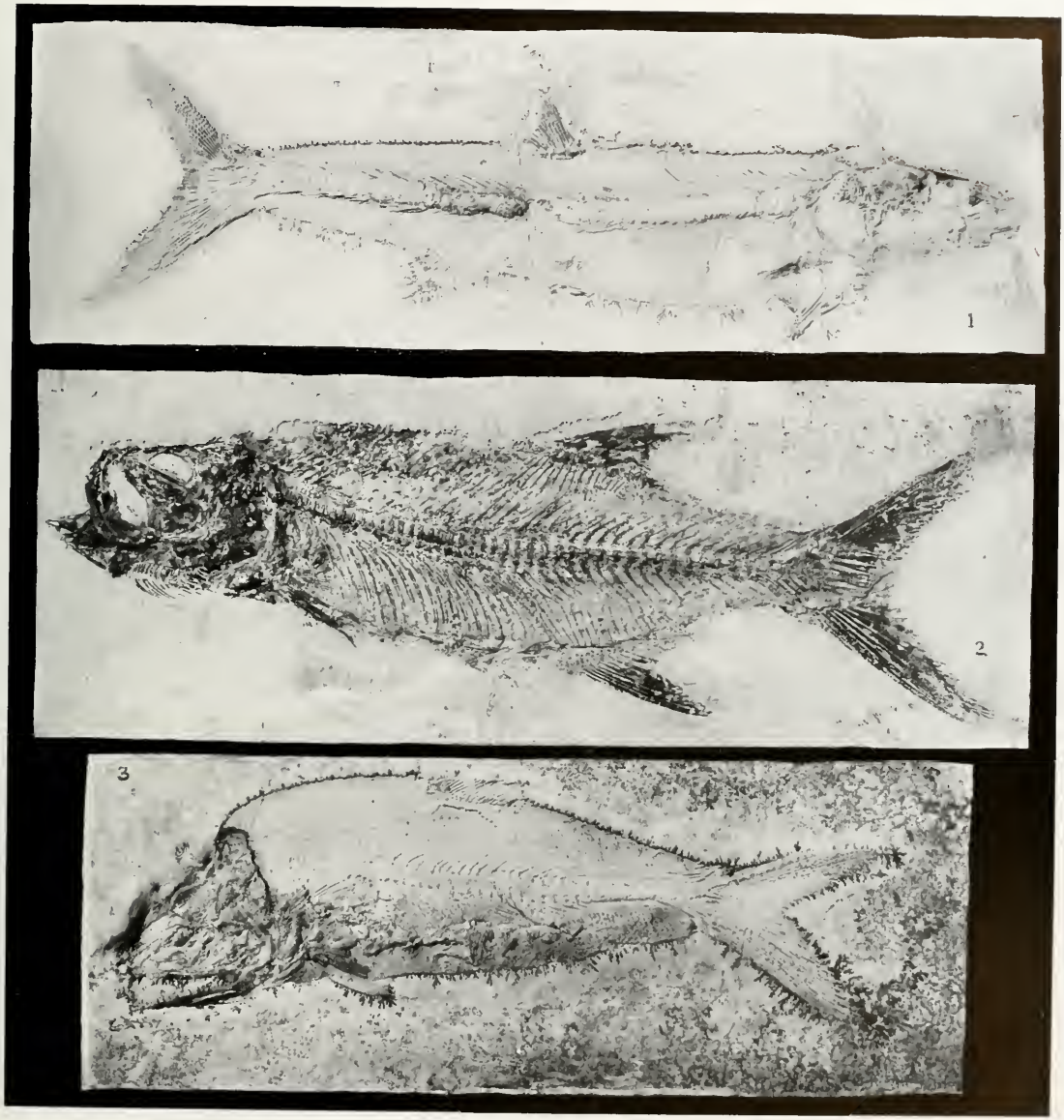

FIG. 1. *Caturus pachyurus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4724 (405 MM.).
FIG. 2. *Parathrissops furcatus* GEN. ET SP. NOV. C. M. CAT. FOSS. FISHES, No. 4029 (235 MM.). TYPE.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 872 (194 MM.).

FIG. 1. *Belonostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4850 (292 MM.).
FIG. 2. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 871 (200 MM.).
FIG. 3. *Sauropsis depressus* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4766. (300 MM. FROM END OF LOWER LOBE OF TAIL TO END OF PECTORAL FIN ON SLAB.)

FIG. 1. *Mesodon macropterus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4456 (50 MM.).
FIG. 2. *Mesodon macropterus* (AGASSIZ). (COUNTERPART) DO., No. 4456*a* (50 MM.).
FIG. 3. *Gyrodus frontatus* AGASSIZ. JUV. C. M. CAT. FOSS. FISHES, No. 3003 (57 MM.). FIGURE REVERSED ON PLATE.
FIG. 4. *Caturus furcatus* VAR. *macrurus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 866 (155 MM.).
FIG. 5. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4809 (483 MM.).

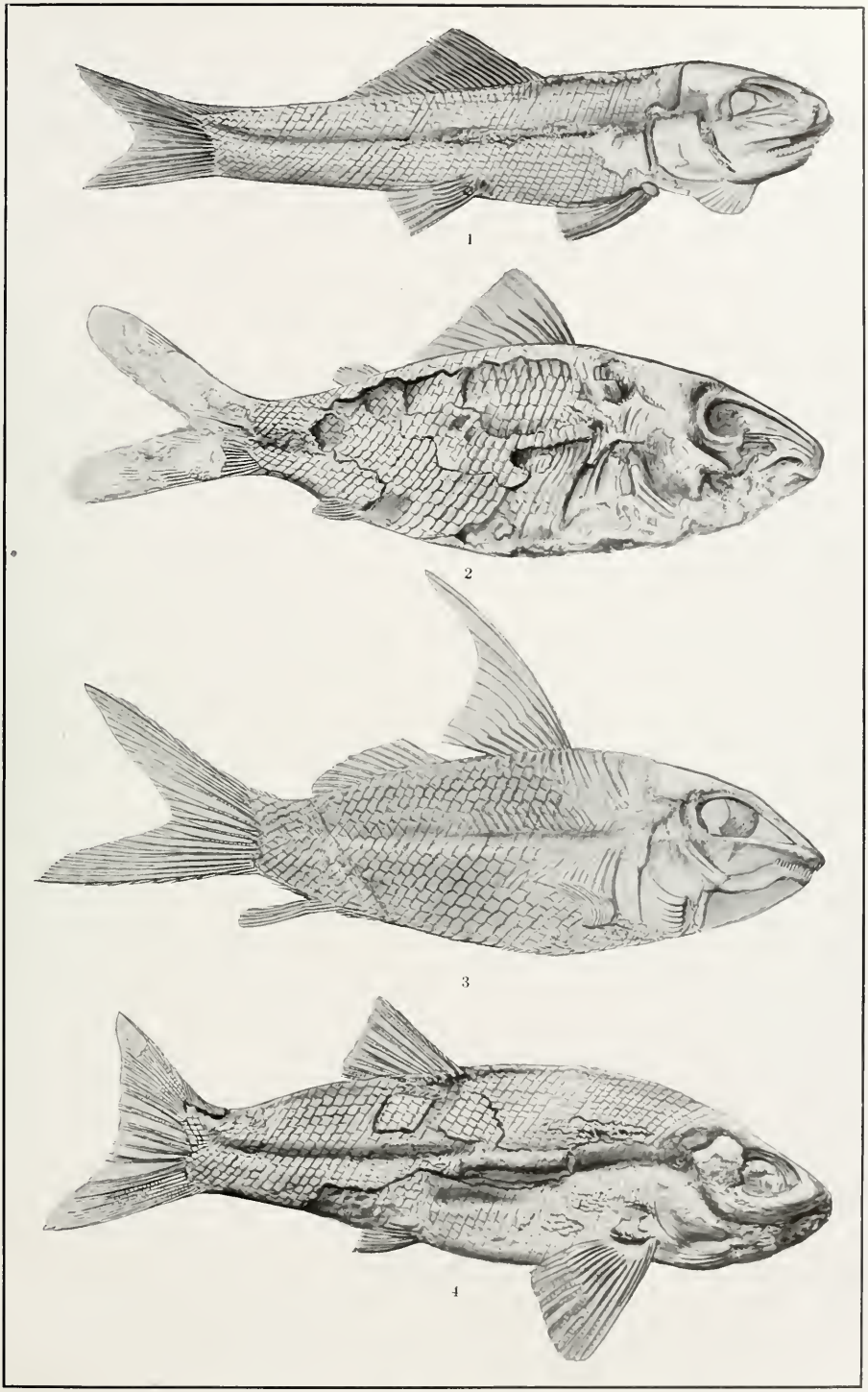

FIG. 1. *Ophiopsis attenuata* WAGNER. C. M. CAT. FOSS. FISHES, No. 4856 (96 MM.).
FIG. 2. *Propterus conidens* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4825 (93 MM.). TYPE.
FIG. 3. *Propterus microstomus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4468 (96 MM.).
FIG. 4. *Histionotus reclinis* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5002 (95 MM.). TYPE.

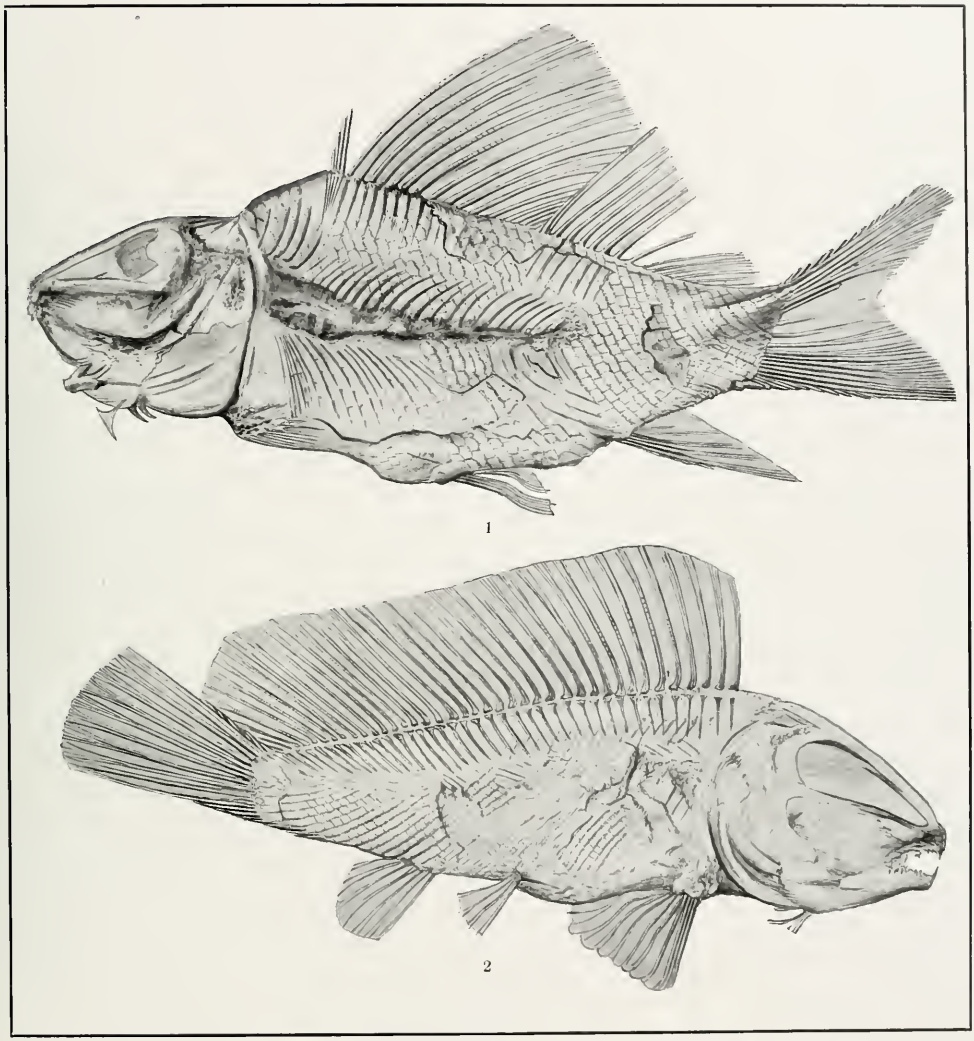

FIG. 1. *Propterus speciosus* WAGNER. C. M. CAT. FOSS. FISHES, No. 4718 (167 MM.).
FIG. 2. *Macrosemius rostratus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4764 (160 MM.).

FIG. 1. *Eugnathus longiserratus* (AGASSIZ). C. M. CAT. FOSS. FISHES, NO. 4719 (145 MM.).
FIG. 2. *Eugnathus longiserratus* (AGASSIZ). C. M. CAT. FOSS. FISHES, NO. 4686 (180 MM.).
FIG. 3. *Aspidorhynchus acutirostris* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4823 (152 MM.).

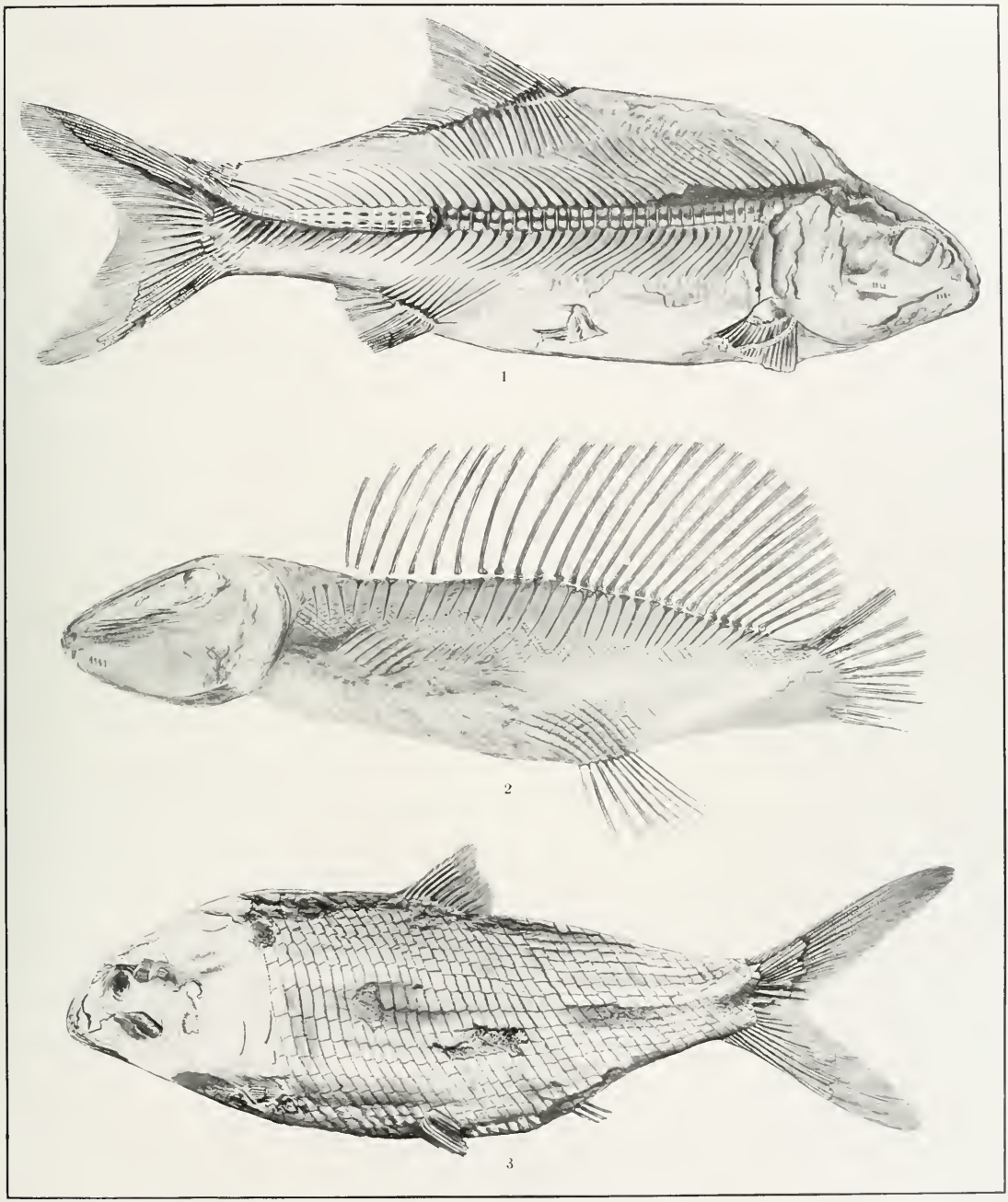

FIG. 1. *Œonoscopus cyprinoides* (WAGNER). C. M. CAT. FOSS. FISHES, NO. 4700 (324 MM.).
FIG. 2. *Macrosemius dorsalis* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4765 (195 MM.). TYPE.
FIG. 3. *Pholidophorus macrocephalus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4729 (297 MM.).

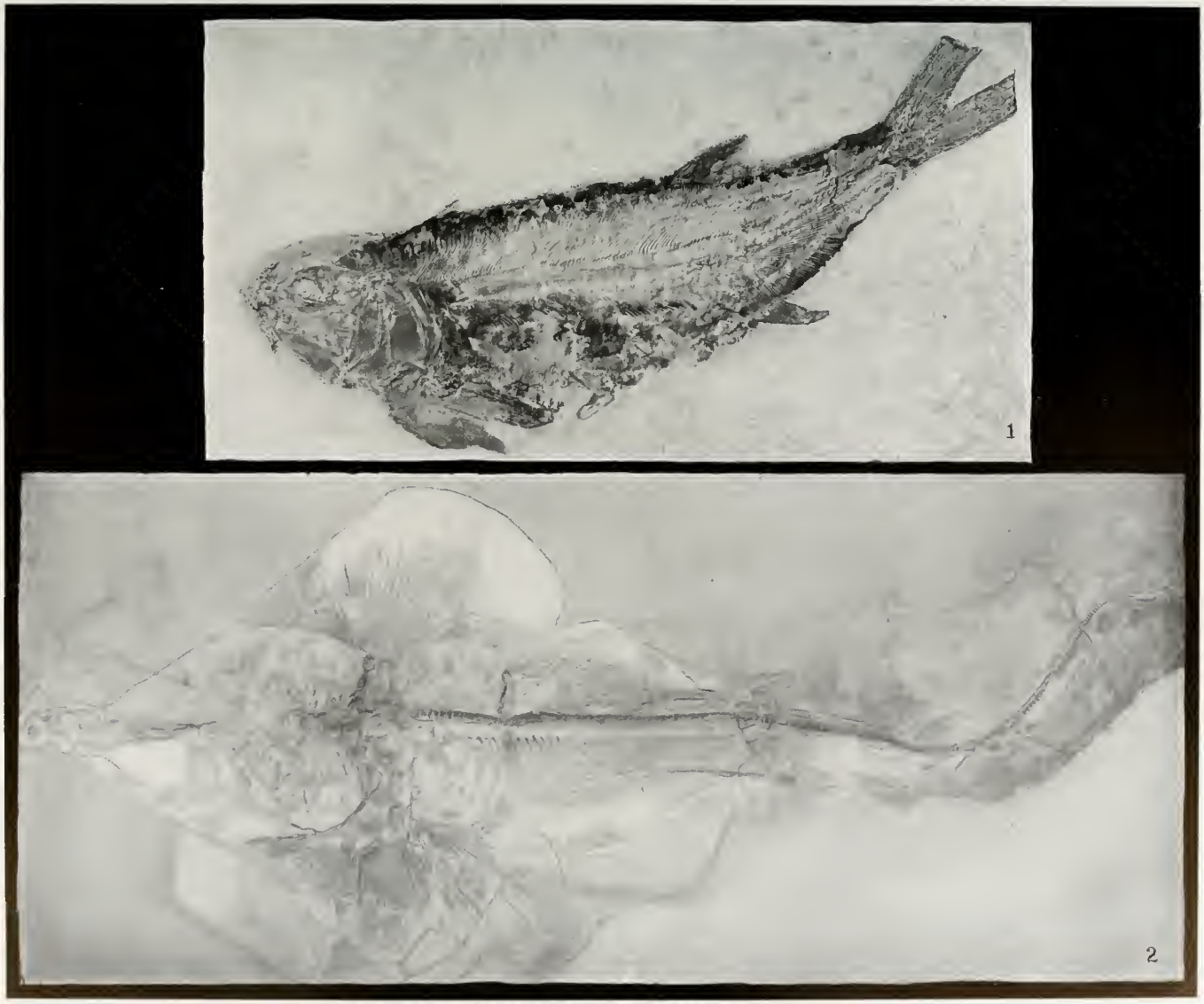

FIG. 1. *Sauropsis curtus* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4772 (265 MM.). TYPE.
FIG. 2. *Rhinobatus bugesiacus* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 5396 (137.5 CM.).

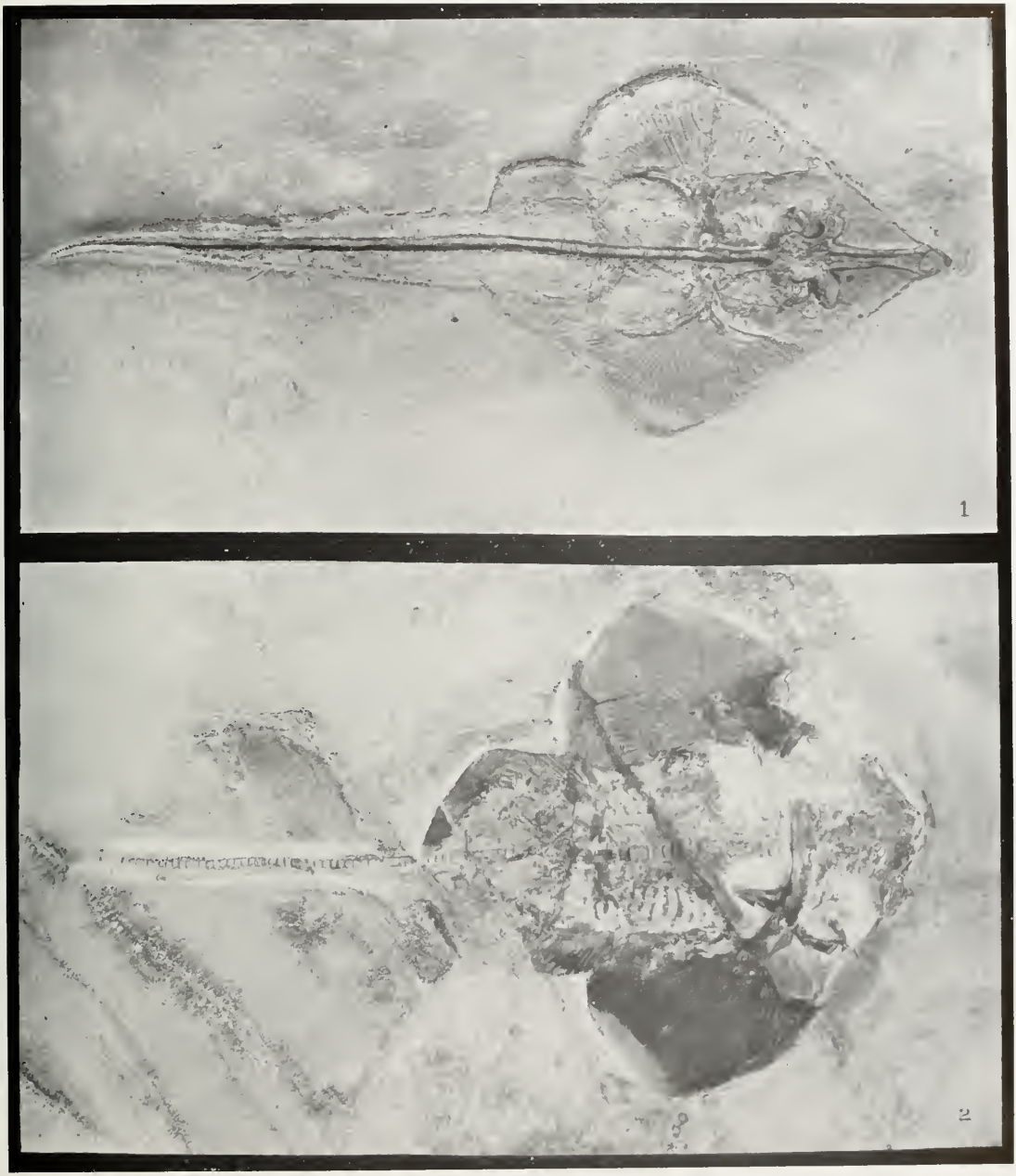

FIG. 1. *Belemnobatis sismonda* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4408. 683 MM.
FIG. 2. *Squatina alifera* MÜNSTER. C. M. CAT. FOSS. FISHES, No. 5397. 965 MM.

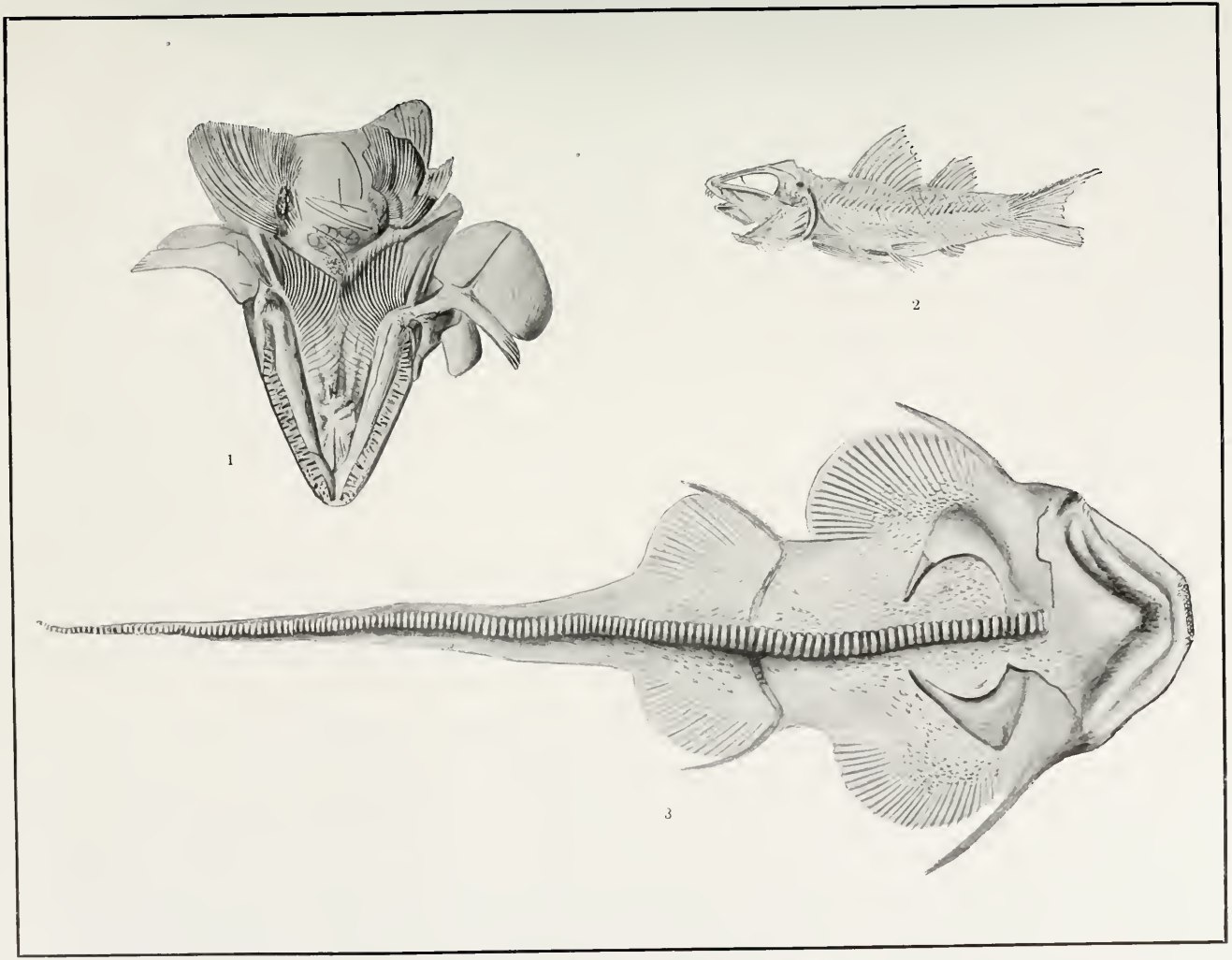

FIG. 1. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4451. × $\frac{1}{1}$.
FIG. 2. *Notagogus decoratus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5110. × $\frac{3}{2}$. (TYPE.)
FIG. 3. *Squatina speciosa* H. VON MEYER. C. M. CAT. FOSS. FISHES, No. 4054. × $\frac{3}{2}$.

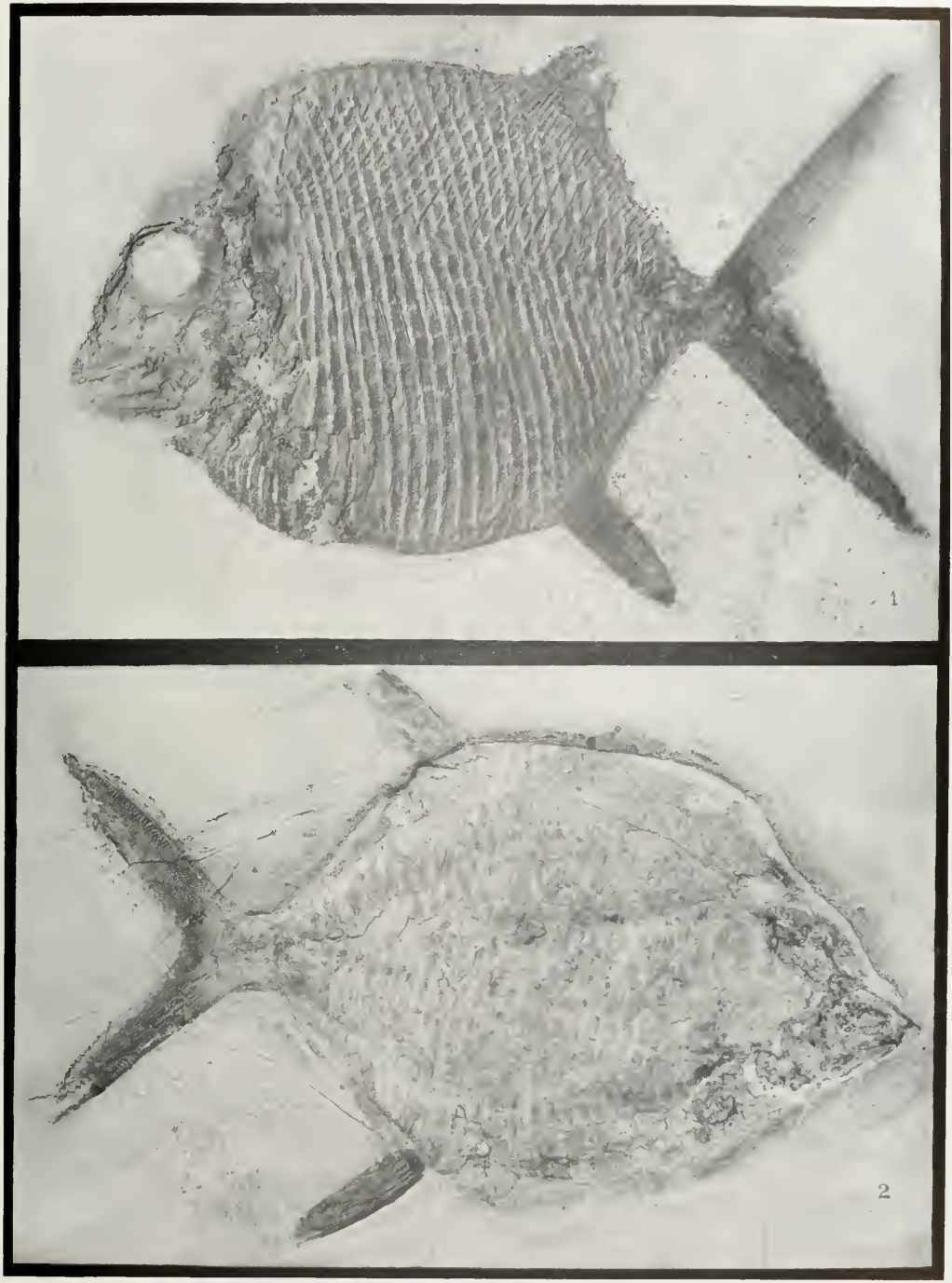

FIG. 1. *Gyrodus macrophthalmus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4734. 252 MM.
FIG. 2. *Gyrodus circularis* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4407. 850 MM.

FIG. 1. *Ophiopsis procera* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4690. 140 MM.
FIG. 2. *Megalurus elegantissimus* WAGNER. C. M. CAT. FOSS. FISHES, No. 4854. 142 MM.
FIG. 3. *Megalurus lepidotus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4732. 365 MM.

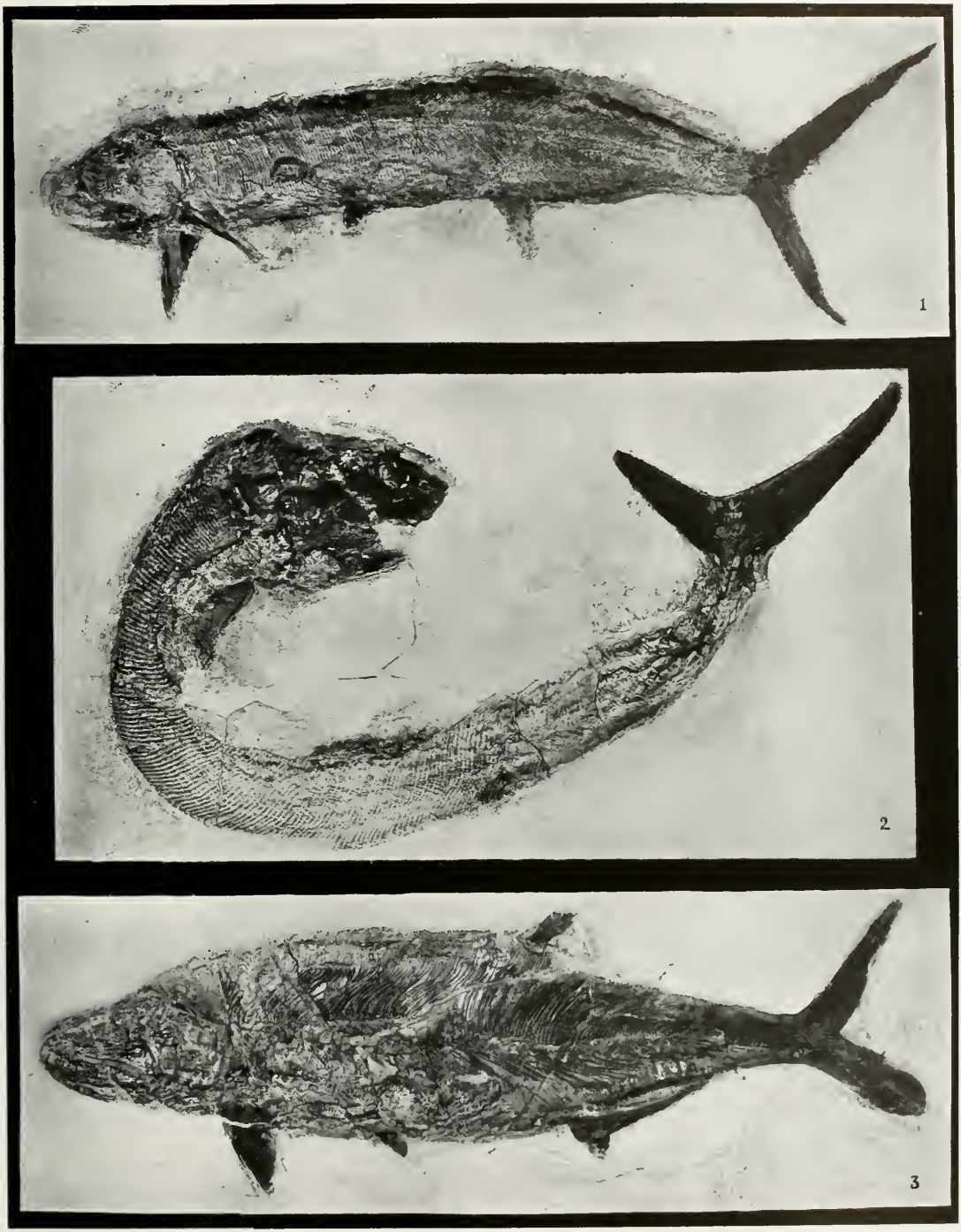

FIG. 1. *Hypsocormus macrodon* (WAGNER). C. M. CAT. FOSS. FISHES, NO. 5399. 705 MM.

FIG. 2. *Hypsocormus macrodon* (WAGNER). C. M. CAT. FOSS. FISHES, NO. 5400. 905 MM. FROM CURVE TO END OF LOWER LOBE OF CAUDAL.

FIG. 3. *Hypsocormus insignis* WAGNER. C. M. CAT. FOSS. FISHES, NO. 5398. 530 MM.

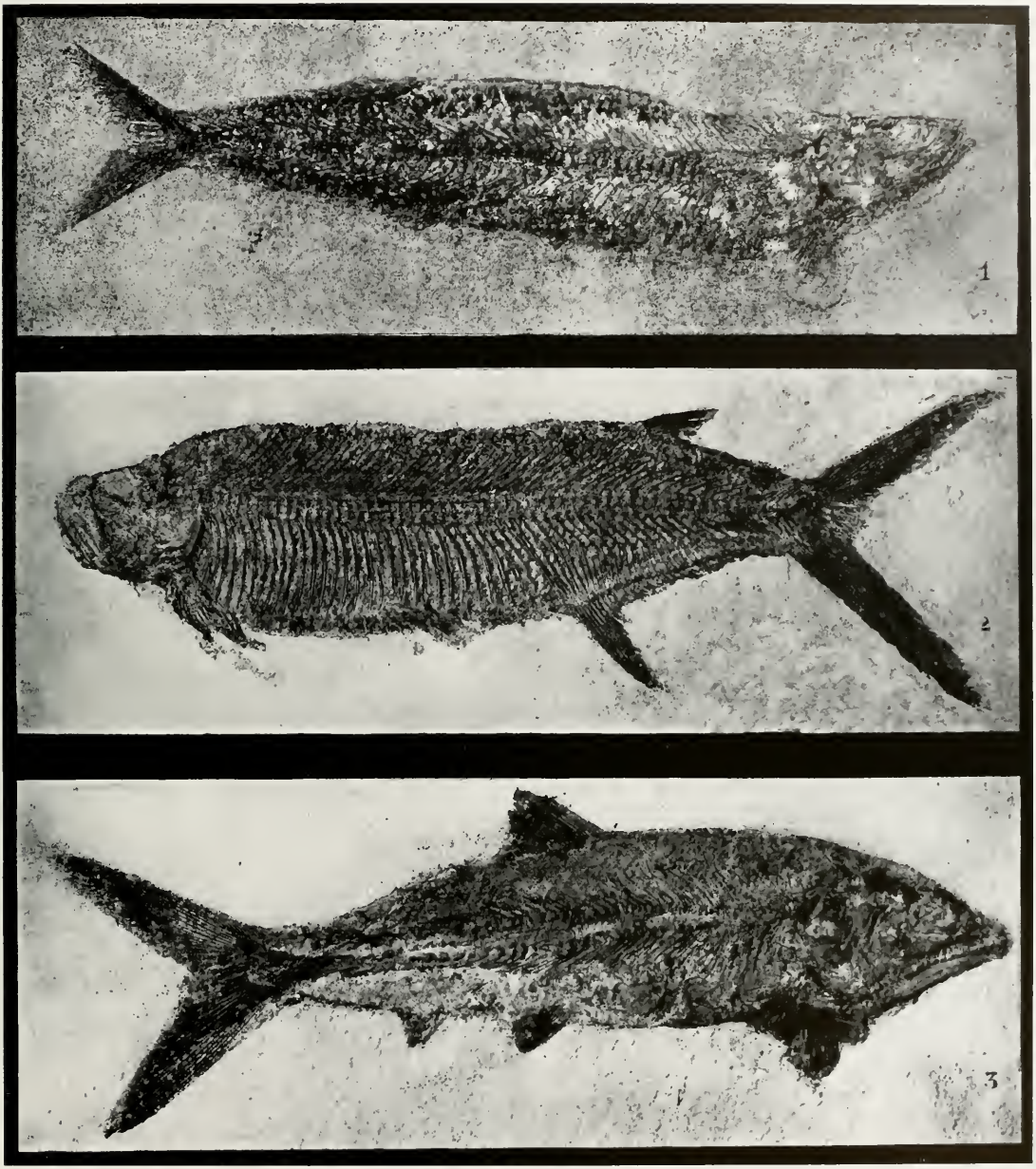

FIG. 1. *Thrissops salmoneus* (BLAINVILLE). C. M. CAT. FOSS. FISHES, No. 4717. 250 MM.
FIG. 2. *Thrissops formosus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4030. 288 MM.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4774. 238 MM.

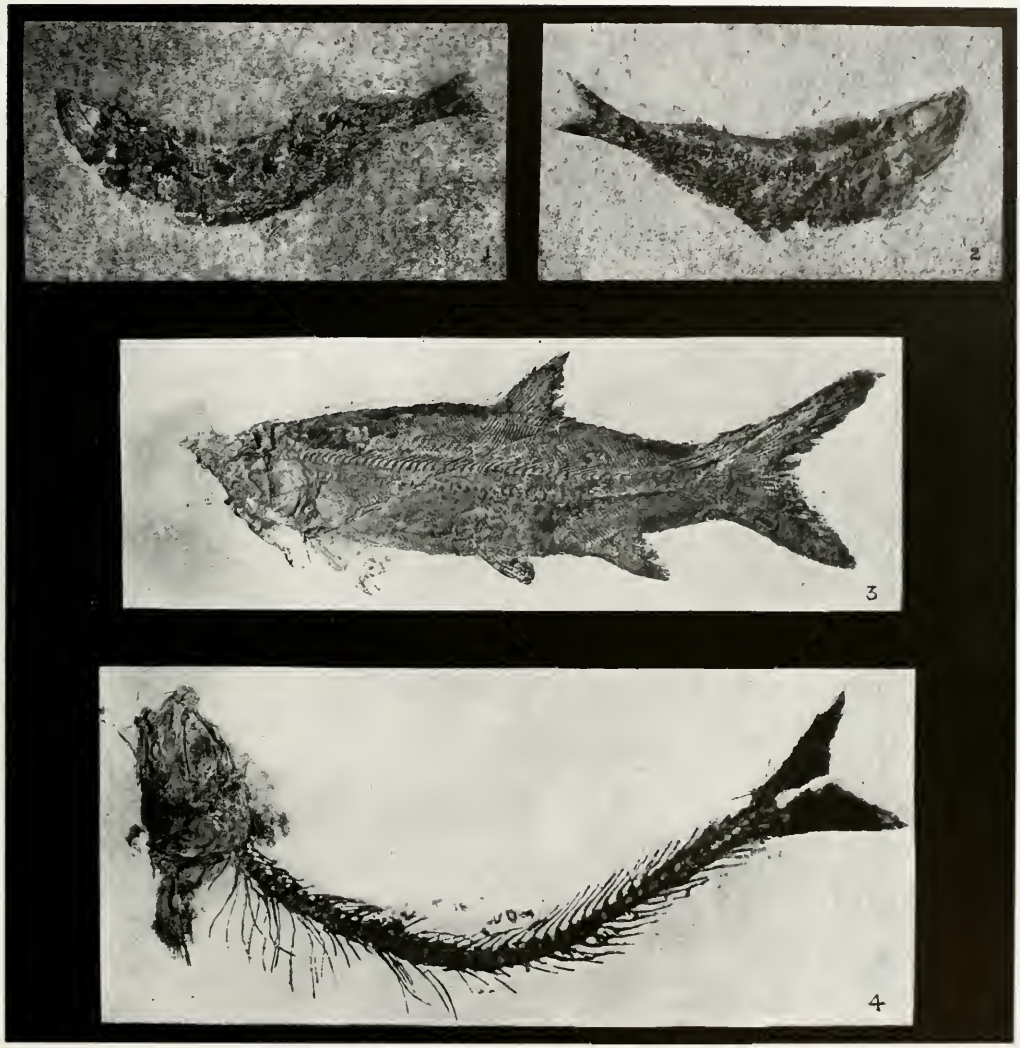

FIG. 1. *Leptolepis sprattiformis* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4108. 95 MM.
FIG. 2. *Leptolepis sprattiformis* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4109. 95 MM.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 5049. 160 MM.
FIG. 4. *Æthalion knorri* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 5017. 180 MM. OVER ALL.

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